PALÆONTOGRAPHICAL SOCIETY.

VOL. LXX.

THE WEALDEN AND PURBECK FISHES.

PART II.

PAGES 49—104; PLATES XI—XX.

THE PLIOCENE MOLLUSCA.

PART III.

PAGES 303—461; PLATES XXXIII—XLIV.

THE PALÆOZOIC ASTEROZOA.

PART III.

PAGES 109—168; PLATES VI—XIII.

BRITISH GRAPTOLITES.

PART XI.

PAGES *a*—*m*, cxlix—clxxi, 527—539. Title-pages and Index.

ISSUED FOR 1916.

PALÆONTOGRAPHICAL SOCIETY.

VOLUME LXX.

CONTAINING

1. THE WEALDEN AND PURBECK FISHES. Part II. By Dr. A. S. WOODWARD. Ten Plates.
2. THE PLIOCENE MOLLUSCA. Part III. By Mr. F. W. HARMER. Twelve Plates.
3. THE PALÆOZOIC ASTEROZOA. Part III. By Mr. W. K. SPENCER. Eight Plates.
4. BRITISH GRAPTOLITES. Part XI. By Miss ELLES and Miss WOOD (Mrs. SHAKESPEAR), edited by Prof. LAPWORTH. Title-page and Index.

ISSUED FOR 1916.

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AGENTS FOR THE SOCIETY
DULAU AND CO., LTD., 37, SOHO SQUARE, W. 1.

FEBRUARY, 1918.

THE PALÆONTOGRAPHICAL SOCIETY was established in the year 1847, for the purpose of figuring and describing British Fossils.

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The Annual Volumes are now issued in *two forms of Binding:* 1st, with all the Monographs stitched together and enclosed in one cover; 2nd, with each of the Monographs in a paper cover, and the whole of the separate parts enclosed in an envelope. Members wishing to obtain the Volume arranged in the LATTER FORM are requested to communicate with the Secretary.

Most of the *back volumes* are in stock. Monographs or parts of Monographs already published can be obtained, apart from the annual volumes, from Messrs. DULAU AND CO., LTD., 37, Soho Square, London, W. 1, who will forward a complete price list on application.

Members desirous of forwarding the objects of the Society can be provided with plates and circulars for distribution on application to the Secretary, Dr. A. SMITH WOODWARD, British Museum (Nat. Hist.), South Kensington, London, S.W. 7.

The following Monographs are in course of preparation and publication :

The Cambrian Trilobites, by Mr. Philip Lake.

The Palæozoic Asterozoa, by Mr. W. K. Spencer.

The Ordovician and Silurian Mollusca, by Dr. Wheelton Hind.

The Pliocene Mollusca, by Mr. F. W. Harmer.

The Pleistocene Mammalia, by Prof. S. H. Reynolds

The Wealden and Purbeck Fishes, by Dr. A. Smith Woodward.

ANNUAL REPORT

OF THE

PALÆONTOGRAPHICAL SOCIETY, 1916,

WITH

LIST

OF

The Council, Secretaries, and Members

AND

A LIST OF THE CONTENTS OF THE VOLUMES ALREADY PUBLISHED.

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ANNUAL REPORT OF THE COUNCIL

FOR THE YEAR ENDING 31ST DECEMBER, 1915.

READ AND ADOPTED AT THE

ANNUAL GENERAL MEETING,

HELD AT THE APARTMENTS OF THE GEOLOGICAL SOCIETY, BURLINGTON HOUSE, 24TH MARCH, 1916.

DR. HENRY WOODWARD, F.R.S., PRESIDENT,

IN THE CHAIR.

THE COUNCIL, in presenting its Sixty-ninth Annual Report, regrets that the unfortunate circumstances of the time have again hindered the usual progress of the Society's work. The volume for 1915 will be larger than that of the previous year, with an increased number of plates, and will contain another instalment of Mr. W. K. Spencer's Monograph of Palæozoic Asterozoa and the first part of a new Monograph of Wealden and Purbeck Fishes by Dr. A. Smith Woodward; but it will still be smaller than usual, and its publication is delayed at least until the autumn of 1916. The Council, however, has reason to anticipate that, as soon as normal times return, the contributions offered will become as numerous and varied as heretofore, and the deficiency in published matter will be made up by a larger annual issue.

The delay and diminution of the volumes for 1914 and 1915 have again made the analysis of the balance-sheet difficult; but it may be noted that the income exceeded the expenditure by nearly £120. Most of the accumulated balance which will be needed for the anticipated publications of the immediate future, remains on deposit, but the Council resolved to invest part of this sum in the purchase of £200 War Loan at a cost of £199 6*s.* 8*d.*

During the year the Council received with regret the resignation of two of its number, Sir Archibald Geikie and the Right Rev. Bishop Mitchinson. Both had rendered devoted service to the Society for many years, and the Council passed special resolutions expressing their high appreciation of this service.

The thanks of the Society are due to the Council of the Geological Society for permission both to store the stock of back volumes, and to hold the Council Meetings and Annual General Meeting in the apartments of the Society.

In conclusion, it is proposed that, in addition to those who have resigned, Mr. W. K. Spencer be the other retiring member of the Council; that the new members be Miss M. S. Johnston, Mr. H. L. Hawkins, and Mr. G. W. Young; that the new Vice-President be Dr. G. J. Hinde; that the President be Dr. Henry Woodward; the Treasurer, Mr. Robert S. Herries; and the Secretary, Dr. A. Smith Woodward.

Annexed is the Balance-sheet.

THE PALÆONTOGRAPHICAL SOCIETY IN ACCOUNT WITH ROBERT S. HERRIES, ESQ., M.A., F.G.S., TREASURER.

Cr. *From January 1st, 1915, to December 31st, 1915.* *Dr.*

Cr.		£	s.	d.	£	s.	d.
Balance from last Account					719	0	5
Members' Subscriptions—1912–14	89	93	9	0			
,, ,, 1915	154	161	14	0			
,, ,, 1916	7	7	7	0			
	250				262	10	0
Carriage paid by Members					0	17	2
Sales of back stock to Members					51	18	0
Sales by Messrs. Dulau & Co., Ltd.					51	11	2
Repaid Income Tax (1 year)					1	5	7
Dividends on £500 Natal 3 per cent. Stock (less Income Tax)					13	5	8
Dividend on £200 War Loan					4	10	0
Interest on Deposit					15	4	2
					£1120	2	2

Dr.	£	s.	d.	£	s.	d.
Printing, paper, etc., Vol. LXVIII				74	19	3
Binding and distributing Vol. LXVIII				42	10	7
Drawing illustrations, Vol. LXVIII				15	15	0
Collotype printing, Vol. LXVIII				26	10	0
Drawing illustrations, Vol. LXIX				63	4	6
Rent of unused lithographic stones				0	9	0
Secretary's honorarium				52	10	0
Postage and stationery				4	6	7
Fire Insurance on Stock				0	15	0
Petty charges—Porter	0	15	0			
,, ,, Bank	0	2	8			
				0	17	8
Returned carriage paid in error				0	4	0
Purchase of £200 War Loan				199	6	8
Balance at Bank—Deposit Account	550	0	0			
,, ,, Current Account	88	13	11			
				638	13	11
				£1120	2	2

ROBERT S. HERRIES, *Treasurer.*

We have examined the above account, compared it with the vouchers, and find it to be correct; we have also seen the receipts for £500 Natal 3 per cent. Consolidated Stock and for £200 $4\frac{1}{2}$ per cent. War Stock, 1925–1945.

JOHN HOPKINSON
S. HAZZLEDINE WARREN } *Auditors.*
GEORGE W. YOUNG

March 8th, 1916.

LIST OF MEMBERS.*

CORRECTED TO 1st DECEMBER, 1916.

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* Members are requested to inform the Secretary of any errors or omissions in this list, and of any delay in the transmission of the Yearly Volumes.

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Philadelphia (U.S.A.), Academy of Natural Sciences.
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CATALOGUE OF THE CONTENTS OF THE ANNUAL VOLUMES

ALREADY PUBLISHED BY

THE PALÆONTOGRAPHICAL SOCIETY.

Vol. I.	Issued March, 1848, for the Year 1847	The Crag Mollusca, Part I, Univalves, by Mr. S. V. Wood (pp. i—xii, 1—208, pls. i—xxi, and title-page).
,, II.	Issued July, 1849, for the year 1848	The Reptilia of the London Clay, Vol. I, Part I, Chelonia, &c., by Profs. Owen and Bell (pp. 1—76, pls. i—xxviii, viii A, x A, xiii A, xvi A, xviii A, xix*, xix B, xix C, xix D). The Eocene Mollusca, Part I, Cephalopoda, by Mr. F. E. Edwards (pp. 1—56, pls. i—ix).
,, III.[1]	Issued Aug., 1850, for the Year 1849	The Entomostraca of the Cretaceous Formations, by Mr. T. R. Jones (pp. 1—40, pls. i—vii). The Permian Fossils, by Prof. Wm. King (pp. i—xxxviii, 1—258, pls. i—xxviii*). The Reptilia of the London Clay, Vol. I, Part II, Crocodilia and Ophidia, &c., by Prof. Owen (pp. 1—68, pls. xxix, i—xvi, ii A). The Fossil Corals, Part I, Crag, London Clay, Cretaceous, by Messrs. Milne Edwards and Jules Haime (pp. i—lxxxv, 1—72, pls. i—xi).
,, IV.	Issued June, 1851, for the Year 1850	The Crag Mollusca, Part II, No. 1, by Mr. S. V. Wood (pp. 1—150, pls. i—xii). The Mollusca of the Great Oolite, Part I, Univalves, by Messrs. Morris and Lycett (pp. i—viii, 1—130, pls. i—xv). The Fossil Brachiopoda, Vol. I, Part III, No. 1, Oolitic and Liassic, by Mr. Davidson (pp. 1—64, pls. i—xiii).
,, V.	Issued June, 1851, for the Year 1851	The Reptilia of the Cretaceous Formations, by Prof. Owen (pp. 1—118, pls. i—xxxvii, vii A, ix A). The Fossil Corals, Part II, Oolitic, by Messrs. Milne Edwards and Jules Haime (pp. 73—146, pls. xii—xxx). The Fossil Lepadidæ, by Mr. Charles Darwin (pp. i—vi, 1—88, pls. i—v).
,, VI.	Issued Aug., 1852, for the Year 1852	The Fossil Corals, Part III, Permian and Mountain-limestone, by Messrs. Milne Edwards and Jules Haime (pp. 147—210, pls. xxxi—xlvi). The Fossil Brachiopoda, Vol. I, Part I, Tertiary, by Mr. Davidson (pp. 1—23, pls. i, ii). The Fossil Brachiopoda, Vol. I, Part II, No. 1, Cretaceous, by Mr. Davidson (pp. 1—54, pls. i—v). The Fossil Brachiopoda, Vol. I, Part III, No. 2, Oolitic, by Mr. Davidson (pp. 65—100, pls. xiv—xviii). The Eocene Mollusca, Part II, Pulmonata, by Mr. F. E. Edwards (pp. 57—122, pls. x—xv). The Echinoderms of the Crag, London Clay, &c., by Prof. E. Forbes (pp. i—viii, 1—36, pls. i—iv, and title-page).
,, VII.	Issued Dec., 1853, for the Year 1853	The Fossil Corals, Part IV, Devonian, by Messrs. Milne Edwards and Jules Haime (pp. 211—244, pls. xlvii—lvi). The Fossil Brachiopoda, Introduction to Vol. I, by Mr. Davidson (pp. 1—136, pls. i—ix). The Mollusca of the Chalk, Part I, Cephalopoda, by Mr. D. Sharpe (pp. 1—26, pls. i—x). The Mollusca of the Great Oolite, Part II, Bivalves, by Messrs. Morris and Lycett (pp. 1—80, pls. i—viii). The Mollusca of the Crag, Part II, No. 2, Bivalves, by Mr. S. V. Wood (pp. 151—216, pls. xiii—xx). The Reptilia of the Wealden Formations, Part I, Chelonia, by Prof. Owen (pp. 1—12, pls. i—ix).

[1] The Volume for the year 1849 consists of two separate portions, each of which is stitched in a paper cover, on which are printed the dates 1848, 1849, and 1850. The one portion contains 'Cretaceous Entomostraca' and 'Permian Fossils'; the other, 'London Clay Reptilia,' Part II, and 'Fossil Corals,' Part I.

CATALOGUE OF VOLUMES—Continued.

Vol. VIII.[1] Issued May, 1855, for the Year 1854

- The Fossil Brachiopoda, Vol. I, Part II, No. 2, Cretaceous (pp. 55—117, pls. vi—xii), with Appendix and Index to Vol. I, by Mr. Davidson (pp. 1—30, pl. A).
- The Reptilia of the Wealden Formations, Part II, Dinosauria, by Prof. Owen (pp. 1—54, pls. i—xix, xvi A).
- The Mollusca of the Great Oolite, Part III, Bivalves, by Messrs. Morris and Lycett (pp. 81—147, pls. ix—xv).
- The Fossil Corals, Part V, Silurian, by Messrs. Milne Edwards and Jules Haime (pp. 245—322, pls. lvii—lxxii).
- The Fossil Balanidæ and Verrucidæ, by Mr. Charles Darwin (pp. 1—44, pls. i, ii).
- The Mollusca of the Chalk, Part II, Cephalopoda, by Mr. D. Sharpe (pp. 27—36, pls. xi—xvi).
- The Eocene Mollusca, Part III, No. 1, Prosobranchiata, by Mr. F. E. Edwards (pp. 123—180, pls. xvi—xxiii).

„ IX.[2] Issued Feb., 1857, for the Year 1855

- The Mollusca of the Crag, Part II, No. 3, Bivalves, by Mr. S. V. Wood (pp. 217—342, pls. xxi—xxxi).
- The Reptilia of the Wealden Formations, Part III, by Prof. Owen (pp. 1—26, pls. i—xii).
- The Eocene Mollusca, Part III, No. 2, Prosobranchiata, continued, by Mr. F. E. Edwards (pp. 181—240, pls. xxiv—xxvii).
- The Mollusca of the Chalk, Part III, Cephalopoda, by Mr. D. Sharpe (pp. 37—68, pls. xvii—xxvii).
- The Tertiary Entomostraca, by Mr. T. R. Jones (pp. i—xii, 1—68, pls. i—vi).
- The Fossil Echinodermata, Oolitic, Vol. I, Part I, by Dr. Wright (pp. v—x, 1—154, pls. i—x).

„ X. Issued April, 1858, for the Year 1856

- The Fossil Echinodermata, Oolitic, Vol. I, Part II, by Dr. Wright (pp. 155—302, pls. xi—xxii).
- The Fossil Crustacea, Part I, London Clay, by Prof. Bell (pp. i—viii, 1—44, pls. i—xi).
- The Fossil Brachiopoda, Vol. II, Part IV, Permian, by Mr. Davidson (pp. 1—51, pls. i—iv).
- The Fossil Brachiopoda, Vol. II, Part V, No. 1, Carboniferous, by Mr. Davidson (pp. 1—48, pls. i—viii).
- The Reptilia of the Wealden Formations, by Prof. Owen, Part IV (pp. 8—26, pls. iv—xi), and Supplement No. 1 (pp. 1—7, pls. i—iii).
- The Reptilia of the London Clay, Vol. I (Supplement), by Prof. Owen (pp. 77—79, pls. xxviii A, xxviii B).

„ XI. Issued Nov., 1859, for the Year 1857

- The Fossil Echinodermata, Oolitic, Vol. I, Part III, by Dr. Wright (pp. 303—390, pls. xxiii—xxxvi).
- The Fossil Brachiopoda, Vol. II, Part V, No. 2, Carboniferous, by Mr. Davidson (pp. 49—80, pls. ix—xvi).
- The Reptilia of the Cretaceous Formations (Supplement No. 1), by Prof. Owen (pp. 1—19, pls. i—iv).
- The Reptilia of the Wealden Formations (Supplement No. 2), by Prof. Owen (pp. 20—44, pls. v—xii.)
- The Polyzoa of the Crag, by Prof. Busk (pp. i—xiv, 1—136, pls. i—xxii).

„ XII. Issued March, 1861, for the Year 1858

- The Fossil Echinodermata, Oolitic, Vol. I, Part IV, by Dr. Wright (pp. 391—468, pls. xxxvii—xliii).
- The Eocene Mollusca, Part III, No. 3, Prosobranchiata continued, by Mr. F. E. Edwards (pp. 241—330, pls. xxviii—xxxiii).
- The Reptilia of the Cretaceous Formations (Supplements No. 2, No. 3), by Prof. Owen (pp. 27—30, pl. vii, pp. 1—25, pls. i—vi).
- The Reptilia of the Purbeck Limestones, by Prof. Owen (pp. 31—39, pl. viii).
- The Fossil Brachiopoda, Vol. II, Part V, No. 3, Carboniferous by Mr. Davidson (pp. 81—120, pls. xvii—xxvi).

„ XIII. Issued Dec., 1861, for the Year 1859

- The Fossil Brachiopoda, Part V, No. 4, Carboniferous, by Mr. Davidson (pp. 121—210, pls. xxvii—xlvii).
- The Reptilia of the Oolitic Formations, No. 1, Lower Lias, by Prof. Owen (pp. 1—14, pls. i—vi).
- The Reptilia of the Kimmeridge Clay, No. 1, by Prof. Owen (pp. 15, 16, pl. vii).
- The Eocene Mollusca, Part IV, No. 1, Bivalves, by Mr. S. V. Wood (pp. 1—74, pls i—xiii).

[1] This Volume is marked on the outside 1855.
[2] This Volume is marked on the outside 1856.

CATALOGUE OF VOLUMES—Continued.

Vol. XIV. Issued May, 1863, for the Year 1860	The Fossil Brachiopoda, Vol. II, Part V, No. 5, Carboniferous, by Mr. Davidson (pp. 211—280, pls. xlviii—lv). The Reptilia of the Oolitic Formations, No. 2, Lower Lias, by Prof. Owen (pp. 1—26, pls. i—xi). The Reptilia of the Kimmeridge Clay, No. 2, by Prof. Owen (pp. 27, 28, pl. xii). The Fossil Estheriæ, by Prof. Rupert Jones (pp. i—x, 1—134, pls. i—v). The Fossil Crustacea, Part II, Gault and Greensand, by Prof. Bell (pp. i—vii, 1—40, pls. i—xi).
,, XV. Issued May, 1863, for the Year 1861	The Fossil Echinodermata, Oolitic, Vol. II, Part I (Asteroidea), by Dr. Wright (pp. 1—130, pls. i—x, x A, xi, xii). Supplement to the Great Oolite Mollusca, by Dr. Lycett (pp. 1—129, pls. xxxi—xlv).
,, XVI. Issued Aug., 1864, for the Year 1862	The Fossil Echinodermata, Cretaceous, Vol. I, Part I, by Dr. Wright (pp. 1—64, pls. i—iii, iii A, iv—vii, vii A, viii, xi). The Trilobites of the Silurian, Devonian, &c., Formations, Part I (Devonian and Silurian), by Mr. J. W. Salter (pp. 1—80, pls. i—vi). The Fossil Brachiopoda, Vol. III, Part VI, No. 1, Devonian, by Mr. Davidson (pp 1—56, pls. i—ix). The Eocene Mollusca, Part IV, No. 2, Bivalves, by Mr. S. V. Wood (pp. 75—136, pls. xiv—xx). The Reptilia of the Cretaceous Formations (Supplement, No. 4), by Prof. Owen (pp. 1—18, pls. i—ix). The Reptilia of the Wealden and Purbeck Formations (Supplement, No. 3), by Prof. Owen (pp. 19—21, pl. x).
,, XVII. Issued June, 1865, for the Year 1863	The Trilobites of the Silurian, Devonian, &c., Formations, Part II, by Mr. J. W. Salter (pp. 81—128, pls. vii—xiv). The Fossil Brachiopoda, Vol. III, Part VI, No. 2, Devonian, by Mr. Davidson (pp. 57—131, pls. x—xx). The Belemnitidæ, Part I, Introduction, by Prof. Phillips (pp. 1—28). The Reptilia of the Liassic Formations, Part I, by Prof. Owen (pp. 1—40, pls. i—xvi).
,, XVIII. Issued April, 1866, for the Year 1864	The Fossil Echinodermata, Oolitic, Vol. II, Part II (Liassic Ophiuroidea), by Dr. Wright (pp. 131—154, pls. xiii—xviii). The Trilobites of the Silurian, Devonian, &c., Formations, Part III, by Mr. J. W. Salter (pp. 129—176, pls. xv—xxv). The Belemnitidæ, Part II, Liassic Belemnites, by Prof. Phillips (pp. 29—52, pls. i—vii). The Pleistocene Mammalia, Part I, Introduction, Felis spelæa, by Messrs. W. Boyd Dawkins and W. A. Sanford (pp. i—l, 1—28, pls. i—v). Title-pages, &c., to the Monographs on the Reptilia of the London Clay, Cretaceous, and Wealden Formations.
,, XIX.[1] Issued Dec., 1866, for the Year 1865	The Crag Foraminifera, Part I, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady (pp. i—vi, 1—72, pls. i—iv). Supplement to the Fossil Corals, Part I, Tertiary, by Dr. Duncan (pp. i—iii, 1—66, pls. i—x). The Fossil Merostomata, Part I, Pterygotus, by Mr. H. Woodward (pp. 1—44, pls. i—ix). The Fossil Brachiopoda, Vol. III, Part VII, No. 1, Silurian, by Mr. Davidson (pp. 1—88, pls. i—xii).
,, XX. Issued June, 1867, for the Year 1866	Supplement to the Fossil Corals, Part IV, No. 1, Liassic, by Dr. Duncan (pp. i—iii, 1—44, pls. i—xi). The Trilobites of the Silurian, Devonian, &c., Formations, Part IV (Silurian), by Mr. J. W. Salter (pp. 177—214, pls. xxv*—xxx). The Fossil Brachiopoda, Vol. III, Part VII, No. 2, Silurian, by Mr. Davidson (pp. 89—168, pls. xiii—xxii). The Belemnitidæ, Part III, Liassic Belemnites, by Prof. Phillips (pp. 53—88, pls. viii—xx).
,, XXI. Issued June, 1868, for the Year 1867	Flora of the Carboniferous Strata, Part I, by Mr. E. W. Binney (pp. 1—32, pls. i—vi). Supplement to the Fossil Corals, Part IV, No. 2, Liassic, by Dr. Duncan (pp. 45—73, pls. xii—xvii). The Fossil Echinodermata, Cretaceous, Vol. I, Part II, by Dr. Wright (pp. 65—112, pls. ix, x, xii—xxi, xxi A, xxi B). The Fishes of the Old Red Sandstone, Part I, by Messrs. J. Powrie and E. Ray Lankester (pp. 1—32, pls. i—v). The Pleistocene Mammalia, Part II, Felis spelæa, continued, by Messrs. W. Boyd Dawkins and W. A. Sanford (pp. 29—124, pls. vi—xix).

[1] From 1865 onwards the Volumes are issued in two forms of binding: first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope. The previous Volumes are not in separate parts.

CATALOGUE OF VOLUMES—Continued.

Vol. XXII.	Issued Feb., 1869, for the Year 1868	Supplement to the Fossil Corals, Part II, No. 1, Cretaceous, by Dr. Duncan (pp. 1—26, pls. i—ix). The Fossil Merostomata, Part II, Pterygotus, by Mr. H. Woodward (pp. 45—70, pls. x—xv). The Fossil Brachiopoda, Vol. III, Part VII, No. 3, Silurian, by Mr. Davidson (pp. 169—248, pls. xxiii—xxxvii). The Belemnitidæ, Part IV, Liassic and Oolitic Belemnites, by Prof. Phillips (pp. 89—108, pls. xxi—xxvii). The Reptilia of the Kimmeridge Clay, No. 3, by Prof. Owen (pp. 1—12, pls. i—iv). The Pleistocene Mammalia, Part III, Felis spelæa, concluded, with F. lynx, by Messrs. W. Boyd Dawkins and W. A. Sanford (pp. 125—176, pls. xx—xxii, xxii A, xxii B, xxiii).
„ XXIII.	Issued Jan., 1870, for the Year 1869	Supplement to the Fossil Corals, Part II, No. 2, Cretaceous, by Dr. Duncan (pp. 27—46, pls. x—xv). The Fossil Echinodermata, Cretaceous, Vol. I, Part III, by Dr. Wright (pp. 113—136, pls. xxii—xxix, xxix A, xxix B). The Belemnitidæ, Part V, Oxford Clay, &c., Belemnites, by Prof. Phillips (pp. 109—128, pls. xxviii—xxxvi). The Fishes of the Old Red Sandstone, Part I (concluded), by Messrs. J. Powrie and E. Ray Lankester (pp. 33—62, pls. vi—xiv). The Reptilia of the Liassic Formations, Part II, by Prof. Owen (pp. 41—82, pls. xvii—xx). The Crag Cetacea, No. 1, by Prof. Owen (pp. 1—40, pls. i—v).
„ XXIV.	Issued Jan., 1871, for the Year 1870	The Flora of the Carboniferous Strata, Part II, by Mr. E. W. Binney (pp. 33—62, pls. vii—xii). The Fossil Echinodermata, Cretaceous, Vol. I, Part IV, by Dr. Wright (pp. 137—160, pls. xxx—xxxix). The Fossil Brachiopoda, Vol. III, Part VII, No. 4, Silurian, by Mr. Davidson (pp. 249—397, pls. xxxviii—l). The Eocene Mollusca, Part IV, No. 3, Bivalves, by Mr. S. V. Wood (pp. 137—182, pls. xxi—xxv). The Fossil Mammalia of the Mesozoic Formations, by Prof. Owen (pp. i—vi, 1—115, pls. i—iv).
„ XXV.	Issued June, 1872, for the Year 1871	The Flora of the Carboniferous Strata, Part III, by Mr. E. W. Binney (pp. 63—96, pls. xiii—xviii). The Fossil Merostomata, Part III, Pterygotus and Slimonia, by Mr. H. Woodward (pp. 71—120, pls. xvi—xx). Supplement to the Crag Mollusca, Part I (Univalves), by Mr. S. V. Wood, with an Introduction on the Crag District, by Messrs. S. V. Wood, jun., and F. W. Harmer (pp. i—xxxi, 1—98, pls. i—vii, and map). Supplement to the Reptilia of the Wealden (Iguanodon), No. IV, by Prof. Owen (pp. 1—15, pls. i—iii). The Pleistocene Mammalia, Part IV, Felis pardus, &c., by Messrs. W. Boyd Dawkins and W. A. Sanford (pp. 177—194, pls. xxiv, xxv). The Pleistocene Mammalia, Part V, Ovibos moschatus, by Mr. W. Boyd Dawkins (pp. 1—30, pls. i—v).
„ XXVI.	Issued Oct., 1872, for the Year 1872	Supplement to the Fossil Corals, Part III (Oolitic), by Prof. Duncan (pp. 1—24, pls i—vii), with an Index to the Tertiary and Secondary Species. The Fossil Echinodermata, Cretaceous, Vol. I, Part V, by Dr. Wright (pp. 161—184, pls. xl—xliv). The Fossil Merostomata, Part IV (Stylonurus, Eurypterus, Hemiaspis), by Mr. H. Woodward (pp. 121—180, pls. xxi—xxx). The Fossil Trigoniæ, No. I, by Dr. Lycett (pp. 1—52, pls. i—ix).

CATALOGUE OF VOLUMES—Continued.

Vol. XXVII. Issued Feb., 1874, for the Year 1873

- The Fossil Echinodermata, Cretaceous, Vol. I, Part VI, by Dr. Wright (pp. 185—224, pls. xlv—lii).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part I (Tertiary and Cretaceous), by Mr. Davidson (pp. 1—72, pls. i—viii).
- Supplement to the Crag Mollusca, Part II (Bivalves), by Mr. S. V. Wood (pp. 99—231, pls. viii—xi, and add. plate).
- Supplement to the Reptilia of the Wealden (Iguanodon), No. V, by Prof. Owen (pp. 1—18, pls. i, ii).
- Supplement to the Reptilia of the Wealden (Hylæochampsa), No. VI, by Prof. Owen (pp. 1—7).
- The Fossil Reptilia of the Mesozoic Formations, Part I, by Prof. Owen (pp. 1—14, pls. i, ii).

,, XXVIII. Issued July, 1874, for the Year 1874

- The Post-Tertiary Entomostraca, by Mr. G. S. Brady, Rev. H. W. Crosskey, and Mr. D. Robertson (pp. i—v, 1—232, pls. i—xvi).
- The Carboniferous Entomostraca, Part I (Cypridinidæ), by Prof. T. Rupert Jones and Messrs. J. W. Kirkby and G. S. Brady (pp. 1—56, pls. i—v).
- The Fossil Trigoniæ, No. II, by Dr. Lycett (pp. 53—92, pls. x—xix).

,, XXIX. Issued Dec. 1875, for the Year 1875

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- The Fossil Trigoniæ, No. III, by Dr. Lycett (pp. 93—148, pls. xx—xxvii).
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,, XXX. Issued Dec., 1876, for the Year 1876

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,, XXXI. Issued Feb., 1877, for the Year 1877

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- The Fossil Trigoniæ, No. IV, by Dr. Lycett (pp. 149—204, pls. xxviii—xl).
- The Eocene Mollusca (Univalves), Part IV, by Mr. S. V. Wood (pp. 331—361, pl. xxxiv).
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,, XXXII. Issued Mar., 1878, for the Year 1878

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- The Fossil Merostomata, Part V (Neolimulus, &c.), by Dr. H. Woodward (pp. 181—263, pls. xxxi—xxxvi, and title-page).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part II, No. 2 (Jurassic and Triassic), by Mr. Davidson (pp. 145—242, pls. xvii—xxix).
- The Lias Ammonites, Part I, by Dr. Wright (pp. 1—48, pls. i—viii).
- The Sirenoid and Crossopterygian Ganoids, Part I, by Prof. Miall (pp. 1—32, pls. i, i A, ii—v).
- Supplement to the Reptilia of the Wealden (Goniopholis, Petrosuchus, and Suchosaurus), No. VIII, by Prof. Owen (pp. 1—15, pls. i—vi).
- The Pleistocene Mammalia, Part A (Preliminary Treatise), by Prof. Boyd Dawkins (pp. i—xxxviii).

CATALOGUE OF VOLUMES—Continued.

Vol. XXXIII. Issued May, 1879, for the Year 1879

- The Eocene Flora, Vol. I, Part I, by Mr. J. S. Gardner and Baron Ettingshausen (pp. 1—38, pls. i—v).
- Second Supplement to the Crag Mollusca (Univalves and Bivalves), by Mr. S. V. Wood (pp. i, ii, 1—58, pls. i—vi, and title-page).
- The Fossil Trigoniæ, No. V, by Dr. Lycett (pp. 205—245, pl. xli, and title-page).
- The Lias Ammonites, Part II, by Dr. Wright (pp. 49—164, pls. ix—xviii).
- Supplement to the Reptilia of the Wealden (Goniopholis, Brachydectes, Nannosuchus, Theriosuchus, and Nuthetes), No. IX, by Prof. Owen (pp. 1—19, pls. i—iv).
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,, XXXIV. Issued May, 1880, for the year 1880

- The Eocene Flora, Vol. I, Part II, by Mr. J. S. Gardner and Baron Ettingshausen (pp. 39—58, pls. vi—xi).
- The Fossil Echinodermata, Oolitic, Vol. II, Part III (Asteroidea and Ophiuroidea), by Dr. Wright (pp. 155—203, pls. xix—xxi, pp. i—iv, and title-page).
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,, XXXV. Issued May, 1881, for the Year 1881

- The Fossil Echinodermata, Cretaceous, Vol. I, Part IX, by Dr. Wright (pp. 301—324, pls. lxx—lxxv).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part IV (Devonian and Silurian, from Budleigh-Salterton Pebble Bed), by Mr. Davidson (pp. 317—368, pls. xxxviii—xlii).
- The Fossil Trigoniæ (Supplement No. 1), by Dr. Lycett (pp. 1—4).
- The Lias Ammonites, Part IV, by Dr. Wright (pp. 265—328, pls. xxii A, xxii B, xli—xlviii).
- The Reptilia of the Liassic Formations, Part III, by Prof. Owen (pp. 83—134, pls. xxi—xxxiii, and title-page).
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,, XXXVI. Issued June, 1882, for the Year 1882

- The Eocene Flora, Vol. I, Part III, by Mr. J. S. Gardner and Baron Ettingshausen (pp. 59—86, pls. xii, xiii, and title-page).
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- The Fossil Echinodermata, Cret., Vol. I, Part X, by Dr. Wright (pp. 325—371, pls. lxxvi—lxxx, and title-page).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part V, by Dr. Davidson (pp. 369—383, and title-page).
  - Do., Vol. V, Part I (Devonian and Silurian), by Dr. Davidson (pp. 1—134, pls. i—vii).
- The Lias Ammonites, Part V, by Dr. Wright (pp. 329—400, pls. xlix—lii, lii A, liii—lxix).

,, XXXVII. Issued Oct., 1883, for the Year 1883

- The Eocene Flora, Vol. II, Part I, by Mr. J. S. Gardner (pp. 1—60, pls. i—ix).
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- The Carboniferous Trilobites, Part I, by Dr. H. Woodward (pp. 1—38, pls. i—vi).
- Supplement to the Fossil Brachiopoda, Vol. V, Part II (Silurian), by Dr. Davidson (pp. 135—242, pls. viii—xvii).
- The Fossil Trigoniæ (Supplement No. 2), by the late Dr. Lycett (pp. 5—19, pls. i—iv, and title-page).
- The Lias Ammonites, Part VI, by Dr. Wright (pp. 401—440, pls. lxx—lxxvii).

,, XXXVIII. Issued Dec., 1884, for the Year 1884

- The Eocene Flora, Vol. II, Part II, by Mr. J. S. Gardner (pp. 61—90, pls. x—xx).
- The Carboniferous Entomostraca, Part I, No. 2, by Prof. T. Rupert Jones, Mr. J. W. Kirkby, and Prof. G. S. Brady (pp. i—iii, 57—92, pls. vi, vii, and title-page).
- The Carboniferous Trilobites, Part II, by Dr. H. Woodward (pp. 39—86, pls. vii—x, and title-page).
- Supplement to the Fossil Brachiopoda, Vol. V, Part III, by Dr. Davidson (pp. 243—476, pls. xviii—xxi, and title-page).
- The Lias Ammonites, Part VII, by Dr. Wright (pp. 441—480, pls. lxxviii—lxxxvii).

CATALOGUE OF VOLUMES—Continued.

Vol. XXXIX. Issued Jan., 1886, for the Year 1885	The Eocene Flora, Vol. II, Part III, by Mr. J. S. Gardner (pp. 91—159, pls. xxi—xxvii, and title-page). The Stromatoporoids, Part I, by Prof. Alleyne Nicholson (pp. i—iii, 1—130, pls. i—xi). The Fossil Brachiopoda (Bibliography), Vol. VI (pp. 1—163), by the late Dr. Davidson and Mr. W. H. Dalton. The Lias Ammonites, Part VIII, by the late Dr. Wright (pp. 481—503, pl. lxxxviii, and title-page).
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,, XLIII. Issued Mar., 1890, for the Year 1889	The Cretaceous Entomostraca (Supplement), by Prof. T. Rupert Jones and Dr. G. J. Hinde (pp. i—viii, 1—70, pls. i—iv). The Jurassic Gasteropoda, Part I, No. 4, by Mr. W. H. Hudleston (pp. 193—224, pls. xii—xvi). The Inferior Oolite Ammonites, Part IV, by Mr. S. S. Buckman (pp. 145—224, pls. xxiv—xxxvi). The Devonian Fauna of the South of England, Part II, by the Rev. G. F. Whidborne (pp. 47—154, pls. v—viii, viii A, ix—xv).
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CATALOGUE OF VOLUMES—Continued.

Vol. XLVI. Issued Nov., 1892, for the Year 1892	The Stromatoporoids, Part IV (*Conclusion*), by Prof. Alleyne Nicholson (pp. 203—234, pls. xxvi—xxix, and title-page). The Palæozoic Phyllopoda, Part II, by Prof. T. R. Jones and Dr. Woodward (pp. 73—124, pls. xiii—xvii). The Jurassic Gasteropoda, Part I, No. 6, by Mr. W. H. Hudleston (pp. 273—324, pls. xxi—xxvi). The Inferior Oolite Ammonites, Part VII, by Mr. S. S. Buckman (pp. 313—344, pls. lvii—lxxvi). The Devonian Fauna of the South of England, Vol. II, Part II, by the Rev. G. F. Whidborne (pp. 57—88, pls. vi—x).
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,, XLIX. Issued Oct., 1895, for the Year 1895	The Crag Foraminifera, Part II, by Prof. T. R. Jones (pp. 73—210, pls. v—vii). The Jurassic Gasteropoda, Part I, No. 8, by Mr. W. H. Hudleston (pp. 391—444, pls. xxxiii—xl). Carbonicola, Anthracomya, and Naiadites, Part II, by Dr. W. Hind (pp. 81—170, pls. xii—xx). The Devonian Fauna of the South of England, Vol. II, Part IV, by the Rev. G. F. Whidborne (pp. 161—212, pls. xviii—xxiv).
,, L. Issued Oct., 1896, for the Year 1896	The Crag Foraminifera, Part III, by Prof. T. R. Jones (pp. 211—314). The Jurassic Gasteropoda, Part I, No. 9, by Mr. W. H. Hudleston (pp. 445—514, pls. xli—xliv, and title-page). Carbonicola, Anthracomya, and Naiadites, Part III, by Dr. W. Hind (pp. 171—182, pl. xxi, and title-page). The Carboniferous Lamellibranchiata, Part I, by Dr. W. Hind (pp. 1—80, pls. i, ii). The Devonian Fauna of the South of England, Vol. III, Part I, by the Rev. G. F. Whidborne (pp. 1—112, pls. i—xvi).
,, LI. Issued Dec., 1897, for the Year 1897	The Crag Foraminifera, Part IV, by Prof. T. R. Jones (pp. vii—xv, 315—402, and title-page). The Carboniferous Lamellibranchiata, Part II, by Dr. W. Hind (pp. 81—208, pls. iii—xv). The Carboniferous Cephalopoda of Ireland, Part I, by Dr. A. H. Foord (pp. 1—22, pls. i—vii). The Devonian Fauna of the South of England, Vol. III, Part II, by the Rev. G. F. Whidborne (pp. 113—178, pls. xvii—xxi).
,, LII. Issued Dec., 1898, for the Year 1898	The Palæozoic Phyllopoda, Part III, by Prof. T. R. Jones and Dr. Woodward (pp. 125—176, pls. xviii—xxv). The Carboniferous Lamellibranchiata, Part III, by Dr. W. Hind (pp. 209—276, pls. xvi—xxv). The Inferior Oolite Ammonites, Part X, by Mr. S. S. Buckman (pp. i—xxxii, Suppl. pls. i—iv). The Carboniferous Cephalopoda of Ireland, Part II, by Dr. A. H. Foord (pp. 23—48, pls. viii—xvii). The Devonian Fauna of the South of England, Vol. III, Part III, by the Rev. G. F. Whidborne (pp. 179—236, pls. xxii—xxxviii).

CATALOGUE OF VOLUMES—Continued.

Vol. LIII.	Issued Dec., 1899, for the Year 1899	The Palæozoic Phyllopoda, Part IV, by Prof. T. R. Jones and Dr. Woodward (pp. i—xv, 175, 176, 177—211, pls. xxvi—xxxi, and title-page). The Cretaceous Lamellibranchia, Part I, by Mr. H. Woods (pp. 1—72, pls. i—xiv). The Carboniferous Lamellibranchiata, Part IV, by Dr. W. Hind (pp. 277—360, pls. xxvi—xxxix). The Inferior Oolite Ammonites, Part XI, by Mr. S. S. Buckman (pp. xxxiii—lxiv, pls. v—xiv).
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„ LV.	Issued Dec., 1901, for the Year 1901	The Cretaceous Lamellibranchia, Part III, by Mr. H. Woods (pp. 113—144, pls. xx—xxvi). The Carboniferous Lamellibranchiata, Vol. II, Part I, by Dr. W. Hind (pp. 1—34, pls. i—vi), Title-page and Index for Vol. I. The Carboniferous Cephalopoda of Ireland, Part IV, by Dr. A. H. Foord (pp. 127—146, pls. xxxiii—xxxix). British Graptolites, Part I, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. 1—54, pls. i—iv). Ganoid Fishes of British Carboniferous Formations—Part I, Palæoniscidæ, No. 2, by Dr. Ramsay H. Traquair (pp. 61—87, pls. viii—xviii).
„ LVI.	Issued Dec., 1902, for the Year 1902	The Cave Hyæna, by Prof. S. H. Reynolds (pp. 1—25, pls. i—xiv). The Fishes of the English Chalk, Part I, by Dr. A. Smith Woodward (pp. 1—56, pls. i—xiii). The Cretaceous Lamellibranchia, Part IV, by Mr. H. Woods (pp. 145—196, pls. xxvii—xxxviii). British Graptolites, Part I, No. 2,, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. i—xxviii, 55—94, pls. v—xiii).
„ LVII.	Issued Dec., 1903, for the Year 1903	The Fishes of the English Chalk, Part II, by Dr. A. Smith Woodward (pp. 57—96, pls. xiv—xx). The Cretaceous Lamellibranchia, Part V, by Mr. H. Woods (pp. i—xliii, 197—232, pls. xxxix—xlii), Title-page and Index for Vol. I. The Carboniferous Lamellibranchiata, Vol. II, Part II, by Dr. W. Hind (pp. 35—124, pls. vii—xxi). The Carboniferous Cephalopoda of Ireland, Part V, by Dr. A. H. Foord (pp. 147—234, pls. xl—xlix), Title-page and Index. The Lower Palæozoic Trilobites of Girvan, Part I, by Mr. F. R. Cowper Reed (pp. 1—48, pls. i—vi). British Graptolites, Part III, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. xxix—lii, 103—134, pls. xiv—xix).
„ LVIII.	Issued Dec., 1904, for the Year 1904	The Fishes of the Old Red Sandstone, Part II, No. 2, by Dr. R. H. Traquair (pp. 91—118, pls. xix—xxvi). The Cretaceous Lamellibranchia, Vol. II, Part I, by Mr. H. Woods (pp. 1—56, pls. i—vii). The Carboniferous Lamellibranchiata, Vol. II, Part III, by Dr. W. Hind (pp. 125—216, pls. xxii—xxv). The Inferior Oolite Ammonites, Part XII, by Mr. S. S. Buckman (pp. lxv—clxviii, pls. xv—xix). The Lower Palæozoic Trilobites of Girvan, Part II, by Mr. F. R. Cowper Reed (pp. 49—96, pls. vii—xiii). British Graptolites, Part IV, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. liii—lxxii, 135—180, pls. xx—xxv).

CATALOGUE OF VOLUMES—Continued.

Vol. LIX. Issued Nov., 1905, for the Year 1905

- The Fossil Echinodermata, Cretaceous, Vol. II, Part III, by Mr. W. K. Spencer (pp. 67—90, pls. xvii—xxvi).
- The Cretaceous Lamellibranchia, Vol. II, Part II, by Mr. H. Woods (pp. 57—96, pls. viii—xi).
- The Carboniferous Lamellibranchiata, Vol. II, Title-pages and Index, by Dr. W. Hind.
- The Inferior Oolite Ammonites, Part XIII, by Mr. S. S. Buckman (pp. clxix—ccviii, pls. xx—xxiv).
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„ LX. Issued Dec., 1906, for the Year 1906

- The Pleistocene Bears, by Prof. S. H. Reynolds (pp. 1—35, pls. i—viii).
- The Fishes of the Old Red Sandstone, Part II, No. 3, by Dr. R. H. Traquair (pp. 119—130, pls. xxvii—xxxi).
- The Cretaceous Lamellibranchia, Vol. II, Part III, by Mr. H. Woods (pp. 97—132, pls. xii—xix).
- The Lower Palæozoic Trilobites of Girvan, Part III, by Mr. F. R. Cowper Reed (pp. 97—186, Title-page and Index, pls. xiv—xx).
- The Cambrian Trilobites, Part I, by Mr. P. Lake (pp. 1—28, pls. i, ii).
- British Graptolites, Part V, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. lxxiii—xcvi, 181—216, pls. xxvi, xxvii).

„ LXI. Issued Dec., 1907, for the Year 1907

- The Sirenoid Ganoids, Part II, by Prof. L. C. Miall (pp. 33—34, Title-page, Preface, and Postscript).
- Ganoid Fishes of British Carboniferous Formations, Part I, Palæoniscidæ, No. 3, by Dr. R. H. Traquair (pp. 87—106, pls. xix—xxiii).
- The Fishes of the English Chalk, Part III, by Dr. A. Smith Woodward (pp. 97—128, pls. xxi—xxvi).
- The Inferior Oolite Ammonites, Part XIV, by Mr. S. S. Buckman (pp. ccix—cclxii, Title-pages, Preface, and Index).
- The Cretaceous Lamellibranchia, Vol. II, Part IV, by Mr. H. Woods (pp. 133—180, pls. xx—xxvii).
- The Fossil Echinodermata, Cretaceous, Vol. II, Part IV, by Mr. W. K. Spencer (pp. 91—132, pls. xxvii—xxix).
- The British Conulariæ, by Miss Ida L. Slater (pp. 1—40, pls. i—v, Title-page and Index).
- The Cambrian Trilobites, Part II, by Mr. P. Lake (pp. 29—48, pls. iii, iv).
- British Graptolites, Part VI, by Miss Elles and Miss Wood (Mrs. Shakespear), edited by Prof. Lapworth (pp. xcvii—cxx, 217—272, pls. xxviii—xxxi).
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- The Cornbrash Fauna, Part II, by the Rev. J. F. Blake (pp. 101—102, Title-page and Index).

„ LXII. Issued Dec., 1908, for the Year 1908

- The Fishes of the English Chalk, Part IV, by Dr. A. Smith Woodward (pp. 129—152, pls. xxvii—xxxii).
- Illustrations of Type Specimens of Inferior Oolite Ammonites (pls. i—vii).
- The Cretaceous Lamellibranchia, Vol. II, Part V, by Mr. H. Woods (pp. 181—216, pls. xxviii—xxxiv).
- The Fossil Echinodermata, Cretaceous, Vol. II, Part V, by Mr. W. K. Spencer (pp. 133—138, Title-page and Index).
- The Cambrian Trilobites, Part III, by Mr. P. Lake (pp. 49—64, pls. v, vi.)
- British Graptolites, Part VII, by Miss Elles and Miss Wood (Mrs. Shakespear), edited by Prof. Lapworth (pp. cxxi—cxlviii, 273—358, pl. xxxii—xxxv).

„ LXIII. Issued Dec., 1909, for the Year 1909

- The Pleistocene Canidæ, by Prof. S. H. Reynolds (pp. 1—28, pls. i—vi).
- Ganoid Fishes of British Carboniferous Formations, Part I, Palæoniscidæ, No. 4, by Dr. R. H. Traquair (pp. 107—122, pls. xxiv—xxx).
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Palæontographical Society, 1916.

THE FOSSIL FISHES

OF THE

ENGLISH WEALDEN AND PURBECK FORMATIONS.

BY

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PART II.

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not sufficiently expanded to meet round the notochord. Fin-rays robust, articulated, and divided distally. Pelvic fins present; dorsal and anal fins deep throughout their extent, the former occupying the hinder half of the back, and the latter somewhat shorter; caudal fin fan-shaped, with a truncated or convex hinder margin, and arising immediately between the posterior extremities of the dorsal and anal fins. Scales usually smooth, covering only the anterior half of the trunk, and complete only in the lower part of the flank.

Type Species.—*Mesodon macropterus* (A. Wagner, *loc. cit.*, 1851, pp. 49, 56,

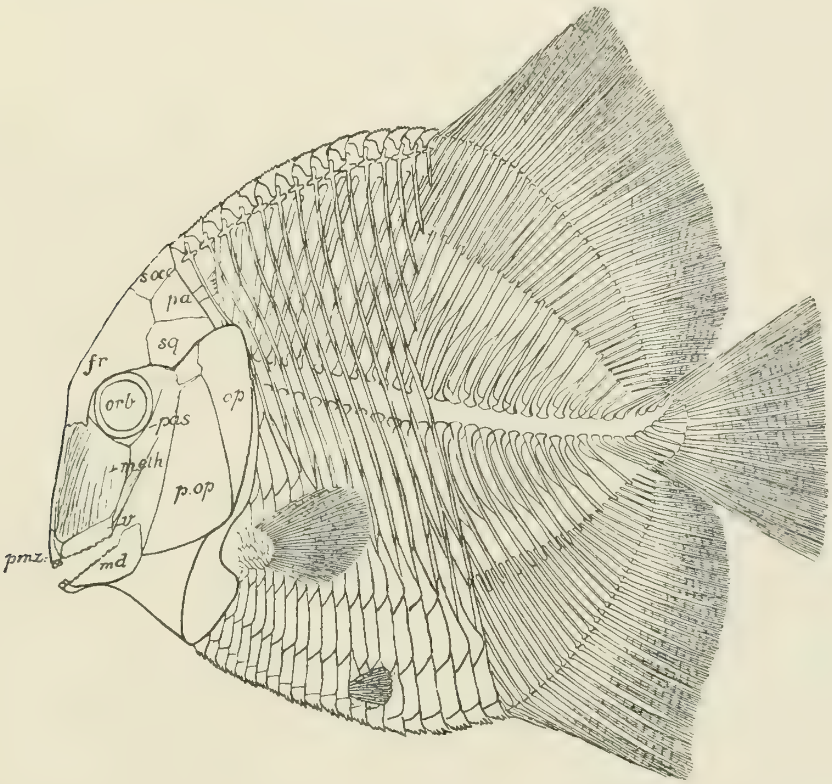


FIG. 20.—*Mesodon macropterus* (Agassiz); restoration, about two-thirds nat. size.—Lower Kimmeridgian (Lithographic Stone); Bavaria. *fr.*, frontal; *m.eth.*, mesethmoid; *md.*, mandible, showing narrow dentary in front; *op.*, operculum; *orb.*, orbit; *p.op.*, preoperculum; *pa.*, parietal; *pas.*, parasphenoid; *pmx.*, premaxilla; *s.occ*, supraoccipital; *sq.*, squamosal; *v.*, vomer.

pl. iv, fig. 2) from the Lower Kimmeridgian (Lithographic Stone) of Kelheim, Bavaria. The species had previously been named *Gyrodus macropterus* by L. Agassiz, Poiss. Foss., Feuill. (1834), p. 18, and vol. ii, pt. ii (1844), p. 301.

Remarks.—In a restoration of the type species of *Mesodon* published in my 'Outlines of Vertebrate Palæontology' (1898), the arrangement of the scales is wrongly based on the Liassic species now named *Eomesodon liassicus* (see below, p. 55). A new restoration is accordingly given in the accompanying Text-fig. 20.

In a restoration of *Mesodon bernissartensis*, from the Wealden of Belgium, published by R. H. Traquair in his "Poissons Wealdiens de Bernissart" (Ann.

Mus. Roy. Hist. Nat. Belg., vol. v, 1911, fig. 11, p. 30) the limits of the vomer and mesethmoid are erroneously indicated, the posterior digitate process of the parietal is omitted, and the scales at the origin of the pelvic fins are incorrectly shown. Crushed and broken specimens cannot be readily interpreted.

The geological range of typical species seems to be from the Kimmeridgian to the Wealden inclusive.

1. **Mesodon daviesi,** A. S. Woodward. Plate XII, figs. 1, 2.

1890. *Mesodon daviesi*, A. S. Woodward, Proc. Zool. Soc., p. 351, pl. xxviii, fig. 5.
1895. *Mesodon daviesi*, A. S. Woodward, Catal. Foss. Fishes B. M., pt. iii, p. 201.

Type.—Nearly complete fish; British Museum.

Specific Characters.—A species attaining a length of 25 cm. Maximum depth of trunk somewhat less than the length of the fish without caudal fin; head with opercular apparatus contained about three-and-a-half times in the same length; back gently rounded, and dorsal fin arising at the highest point. Principal splenial teeth rounded and smooth, about twice as broad as long, flanked externally by two series of smaller teeth, which are also smooth and often broader than long. Dorsal and anal fins about equally elevated, the latter with 29 or 30 supports and four-fifths as long as the former, which has 38 or 39 supports. Dorsal and ventral ridge-scales each with a row of four or five small denticles which increase slightly in size backwards.

Description of Specimens.—The type specimen (Pl. XII, fig. 1), with its incomplete counterpart, exhibits all the principal characters of the species, except those of the paired fins and the serration of the ridge-scales. A second smaller specimen, apparently of the same species, in the British Museum (no. P. 4381), has a slightly larger head, and agrees well with a more imperfect small specimen in the Dorset County Museum.

The head-bones as preserved in the fossils exhibit a fibrous texture, and the only external ornament is a radiating reticulation, without any tubercles. The parietal in the type specimen bears the usual large posteriorly-directed process with digitate extremity, and the supraoccipital ends abruptly, without any upward production. The orbit is as small as in the type species, and all the characteristic Pycnodont features are vaguely seen in the facial region. The small cleft of the mouth is, as usual, inclined slightly upwards and backwards. The vomerine dentition is seen only in edge-view, but in B. M. no. P. 4381 it is shown to have been slightly convex from side to side. The splenial dentition, partly exposed from the attached face in the same specimen, exhibits the principal teeth flanked outside by two series of teeth, which are also broader than long, while the inner slightly exceed the outer in size. As shown in the type specimen (Pl. XII, fig. 1 *a*),

the transversely elongated principal splenial teeth are smooth and rounded, without any apical pit; the teeth of the first outer flanking series are also smooth, broader than long, and about half as broad as the principal teeth; while (as seen in the counterpart of the same specimen) the teeth of the second flanking series are somewhat smaller, but still broader than long. One tooth of the first flanking series exhibits an apical pit. The dentary bone (Pl. XII, fig. 2, *d.*), of the usual Pycnodont shape, bears two chisel-shaped teeth, of which the inner is the larger.

The triangular preoperculum (Pl. XII, figs. 1, 2, *pop.*) does not extend so far upwards as the relatively small, deep, and narrow operculum (*op.*); and when well preserved the radiating reticulated ornament of its outer face is very conspicuous (fig. 2, *pop.*). Traces of calcified gill-supports are seen beneath it in the Dorset Museum specimen.

The vacant space for the notochord forms a nearly straight band somewhat above the middle of the trunk, and the vertebral arches above and below it exhibit a small basal triangular expansion. In the type specimen (Pl. XII, fig. 1) 33 or 34 neural arches can be counted, the foremost being the stoutest and most widely spaced, while the hindmost three or four are comparatively diminutive and related to the support of the caudal fin. Most of these arches bear traces of the anterior laminar expansion (seen especially in the counterpart of the type), and about 18 may be reckoned as belonging to the abdominal region. The ribs are much expanded in their proximal portion and stout, but do not reach the ventral border of the trunk. There are about 13 hæmal arches in advance of the tail in the caudal region, nearly symmetrical with the opposed neurals; and at least 7 comparatively short hæmals are crowded together within the base of the caudal fin.

Of the paired fins, only traces of the pectoral are seen in the type specimen. Seven stout hour-glass-shaped supports are preserved in the basal lobe, and the expanse of the fin must have been large, with numerous closely articulated rays. Thirty-nine supports can be counted in the dorsal fin, and about 30 supports in the anal fin; and the dorsal fin is sufficiently well preserved to show that the foremost three or four rays gradually increase in length to the longest. In both these fins the articulations of the rays are close, and the unarticulated base is very short. In the caudal fin there are slightly more than 20 rays, of which those at the upper and lower borders are much crowded, and may be described as partly fulcral.

Remains of the scales cover the whole of the anterior half of the trunk to the origin of the median fins, arranged in 14 transverse series, with traces of the upper end of two more series just in front of the dorsal fin. For the greater part of their length the series of scales are represented in the fossils merely by the thickened inner rib which bears the peg-and-socket articulation. It is only in the lower part of the abdominal region that they are complete. Here they are thick and smooth, with an especially wide inner rib and large peg-and-socket articulation. The ventral ridge-scales are saddle-shaped and (as shown in the Dorset Museum

specimen) each bears a row of four or five small denticles which increase slightly in size backwards. The lowest flank-scales are scarcely deeper than wide, though very irregular in shape. Above these the flank-scales are much deeper than wide, complete to the number of about four in the foremost series, but gradually reduced to one behind. All seem to be more or less irregular, as already described by Hennig in *Mesodon macropterus*.[1] So far as can be determined from the riblets, all the flank-scales are deep and must have been few in a transverse series. The course of the lateral line is not clear, but the upper slime-canal from the occiput to the origin of the dorsal fin is marked by slight transverse expansions on the successive riblets of deep scales immediately below the dorsal ridge. As shown in the Dorset Museum specimen, each dorsal ridge-scale is armed with a row of five small smooth denticles which increase slightly in size backwards. In the type specimen an irregularly elongate-triangular smooth scale, with its short anterior base crimped into three or four digitations (Pl. XII, fig. 1 *d*), occurs within the caudal fin and probably represents the last remnant of the squamation of the upper caudal lobe.

Horizon and Locality.—Middle Purbeck Beds: Swanage, Dorset.

2. **Mesodon parvus**, A. S. Woodward. Plate XII, figs. 3, 4.

1895. *Mesodon macropterus*, var. *parvus*, A. S. Woodward, Geol. Mag. [4], vol. ii, p. 147, pl. vii, fig. 2.

Type.—Fish with incomplete head; British Museum.

Specific Characters.—A small species, probably attaining a length of about 14 cm. Maximum depth of trunk somewhat less than the length of the fish without caudal fin; head with opercular apparatus contained about three times in the same length; back gently rounded, and dorsal fin arising slightly behind the highest point. Teeth frequently indented with a shallow pit; principal splenial teeth rounded and smooth, about twice as broad as long, flanked externally by two series of smaller teeth, the inner broader than long, the outer nearly round. Dorsal and anal fins equally elevated, the latter with about 26 supports and two-thirds as long as the former, which has about 36 supports. Dorsal and ventral ridge-scales with few comparatively large denticles, those of each scale rapidly increasing in size backwards.

Description of Specimens.—The type specimen (Pl. XII, fig. 3) is a fish scarcely more than 5 cm. in length; and a second specimen presented to the British Museum by Mr. T. T. Gething, showing the nearly complete head, is of about the same size. Portions of larger fishes, however, from the same formation and locality, probably belong to this species; one presented to the Museum of Practical

[1] E. Hennig, "*Gyrodus* und die Organisation der Pyknodonten," Palæontographica, vol. liii (1906), p. 172, fig. 8.

Geology (no. 3414) by the Rev. W. R. Andrews, representing an individual at least 14 cm. in length.

The head in Mr. Gething's fossil (Pl. XII, fig. 4) is well preserved in direct side view, with a rather large orbit, partly surrounded by the remains of an ossified sclerotic. The cranial roof is shown only in internal impression, but the supra-occipital is clearly not turned upwards behind, and the parietal bears the usual posterior digitate process. The facial region exhibits the mesethmoidal plate and the edge of the tooth-bearing vomer. The mandibular suspensorium is obscure both in this and in the type specimen, but a fortunate fracture displays the left splenial dentition from its attached face (fig. 4 *a*). The teeth preserved are in three regular series, the large principal teeth being about twice as broad as long, those of the next series also broader than long, but those of the outer series nearly round. There are traces of a shallow apical pit in the crown of two principal splenial teeth in the large specimen; and some of the lateral vomerine teeth are both pitted and faintly crimped. The two dentary teeth (fig. 4 *a*, *d.*), as usual, are chisel-shaped, and the outer of the two is comparatively small.

The maximum width of the nearly triangular preoperculum (Pl. XII, fig. 3, *pop.*) somewhat exceeds half its depth. The deep and narrow operculum (*op.*) is comparatively small. Both these bones are ornamented with sparse and partly reticulating ridges, which radiate backwards from a point on the front margin. Beneath the preoperculum are two branchiostegal rays (*br.*), of which the upper is the larger though both are relatively small. There are distinct traces of calcified gill-supports.

The axial skeleton of the trunk closely resembles that already described in *M. daviesi* (p. 51), but there seem to be only 11 hæmal arches in the caudal region in advance of the tail. The stout ribs are hollow in the fossils, and the two narrow wings in the upper half of each are distinct.

The pectoral fin, with the seven hour-glass-shaped supports in its basal lobe, is conspicuous on the flank above the lower expansion of the clavicle (Pl. XII, fig. 3). The comparatively small pelvic fin, with about 5 slender and much bifurcated rays, is also well seen in the type specimen (Pl. XII, fig. 3), inserted much nearer to the anal than to the pectoral fin. The dorsal and anal fins exhibit 36 and 26 supports respectively in both the small specimens, and their rays are remarkably slender and well-spaced, with less distal bifurcation than usual. The rays in the anal fin of the larger specimen, however, are stouter and more extensively bifurcated. Perhaps the first condition is a mark of immaturity. The caudal fin comprises 18 rays, with two or three slender fulcral rays at the origin above and below.

The scales are as in *M. daviesi* (p. 51), except that the smooth denticles on the dorsal and ventral ridges are coarser. Each dorsal ridge-scale bears three or four denticles which increase slightly in size backwards. Each ventral ridge-scale is more strongly armoured with only two or three denticles, of which the hinder is

much the larger. The smooth complete scales on the lower portion of the flank, becoming reduced backwards, are especially well seen in the type specimen (Pl. XII, fig. 3), and their stout inner rib is still clearer in the second specimen (fig. 4). The dagger-shaped scales of the upper slime-canal are also distinct. The course of the lateral line is obscure in the abdominal region, but it is marked by a row of short tubular calcifications on the tail (fig. 3, *l.l.*). A small smooth rhombic scale occurs on the upper extremity of the caudal lobe.

Horizon and Locality.—Middle Purbeck Beds: Teffont, Wiltshire.

Genus **EOMESODON**, novum.

Generic Characters.—Profile of head especially steep and abdominal region of trunk much deepened; the caudal region relatively small. Head and opercular bones more or less coarsely granulated; jaws and teeth as in *Mesodon*, but with not less than three outer series of splenial teeth. Fins as in *Mesodon*. Scales complete over the whole of the trunk in advance of the median fins, not much deepened; ornamented with more or less coarse granulations.

Type Species.—*Eomesodon liassicus* (*Pycnodus liassicus*, Egerton, Figs. and Descript. Brit. Organic Remains, dec. viii—Mem. Geol. Surv., 1855—no. 10) from the Lower Lias probably of Barrow-on-Soar, Leicestershire, and other English localities.

Remarks.—The species referable to this genus have hitherto been included in *Mesodon*, but they form a group which is well distinguished by the deepening of the large abdominal region and the completeness of the abdominal squamation. The earliest species is *Eomesodon hoeferi*,[1] from the Upper Trias of Hallein, Salzburg, Austria. Next is the type species from the Lower Lias, and then follow the other Jurassic species, *Eomesodon rugulosus*,[2] *E. granulatus*,[3] *E. gibbosus*,[4] and *E. barnesi*, besides an uncertain number of species which are known only by the dentition.

The dorsal elevation of the anterior part of the trunk in the type specimen of *Eomesodon liassicus* is not well shown in Egerton's original figure of this fossil. It is therefore drawn again in the accompanying Text-fig. 21, which indicates some of the principal features of the genus and species. The skull is evidently that of a

[1] *Mesodon hoeferi*, D. G. Kramberger, Beitr. Paläont. und Geol. Oesterr.-Ungarns, vol. xviii (1905), p. 219, pl. xx, fig. 5; pl. xxi, fig. 2.

[2] *Pycnodus rugulosus*. L. Agassiz, Poiss. Foss., vol. ii, pt. ii (1839—44), p. 194, pl. lxxii *a*, fig. 23; *Mesodon rugulosus*, A. S. Woodward, Proc. Geol. Assoc., vol. xii (1892), p. 239, pl. iv, figs. 2—4.

[3] *Pycnodus granulatus*, Graf zu Münster, Beitr. Petrefakt., pt. vii (1846), p. 44, pl. iii, figs. 11, 12; *Mesodon granulatus*, K. Fricke, Palæontogr., vol. xxii (1875), p. 359, pl. xviii, pl. xix, figs. 1—5.

[4] *Mesodon gibbosus*, A. Wagner, Abhandl. k. bay. Akad. Wiss., math.-phys. Cl., vol. vi (1851), pp. 52, 56, pl. iii, fig. 2; E. Hennig, Centralbl. f. Min., 1907, p. 366, figs. 4, 5.

typical Pycnodont, with relatively large frontal bones, a small median supra-occipital plate (*socc.*), a quadrangular parietal (*pa.*), and a rather large squamosal (*sq.*), all closely ornamented with rows of granulations. One of the principal vomerine teeth, as already noted by Egerton, is coarsely crimped or tuberculated round the apex of the crown; a larger ovoid splenial tooth is smooth and not indented. The dentary bone bears two chisel-shaped teeth, of which the inner is the larger. Beneath the large triangular preoperculum there are two branchi-ostegal rays. In the axial skeleton of the trunk, the stout neural spines of the abdominal region do not reach the dorsal border; while neither neurals nor hæmals in the caudal region bear any laminar expansion. In the caudal region,

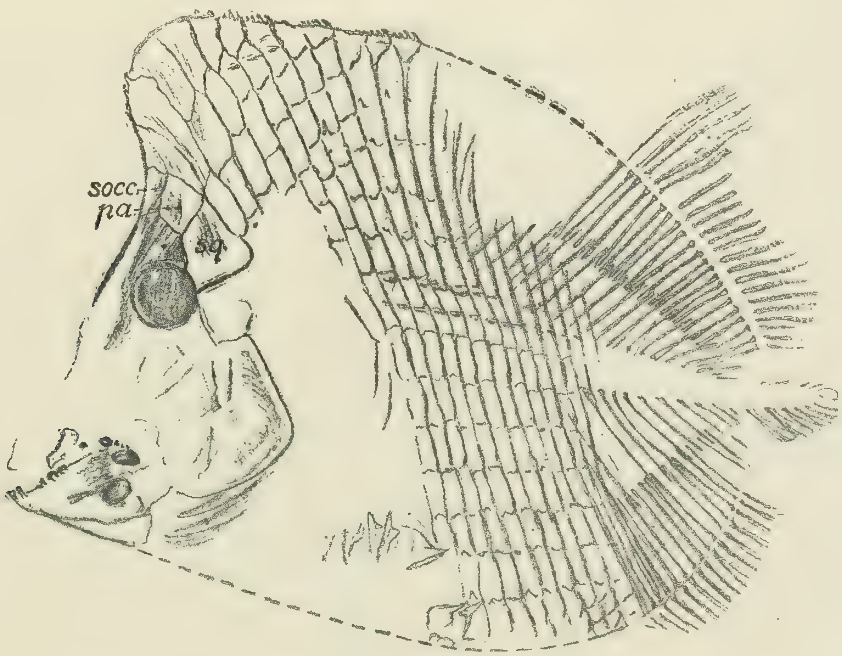


Fig. 21.—*Eomesodon liassicus* (Egerton); drawing of type specimen, nat. size.—Lower Lias; probably Barrow-on-Soar, Leicestershire. B. M. no. 19864. *pa.*, parietal; *socc.*, supraoccipital; *sq.*, squamosal.

however, as especially well seen in a smaller specimen (B. M. no. P. 1336, with counterpart in the Worcester Museum), each neural spine beneath the dorsal fin is double, a short straight rod arising from the front of the neural arch, the long neural spine proper arising behind and curving sharply backwards. The number of rays in the dorsal and anal fins seems to have been smaller than in the typical *Mesodon*. The large dorsal ridge-scales in the anterior part of the eminence are much deepened and modified, but they bear the usual median row of small hooked denticles, of which those in front are inclined backwards, while those behind the eminence seem to be upright or inclined forwards. The ventral ridge-scales are not seen in the type specimen; but three or four immediately in front of the anal fin in the smaller specimen already mentioned appear to be merely pointed and imbricating, without denticles. The lateral line is well marked by a ridge, and the

course of the upper slime-canal is also distinct. In the deepest part of the trunk there appear to be about 8 scales in a transverse series above that traversed by the lateral line, and about 10 scales below this.

1. **Eomesodon barnesi,** A. S. Woodward. Plate XIII, fig. 1; Text-fig. 22.

1906. *Mesodon barnesi,* A. S. Woodward, Proc. Dorset Nat. Hist. Field Club, vol. xxvii, p. 187, pl. B, figs. 1—4.

Type.—Nearly complete fish; collection of the late F. J. Barnes, Esq.

Specific Characters.—Elevation of back sharply rounded, and maximum depth

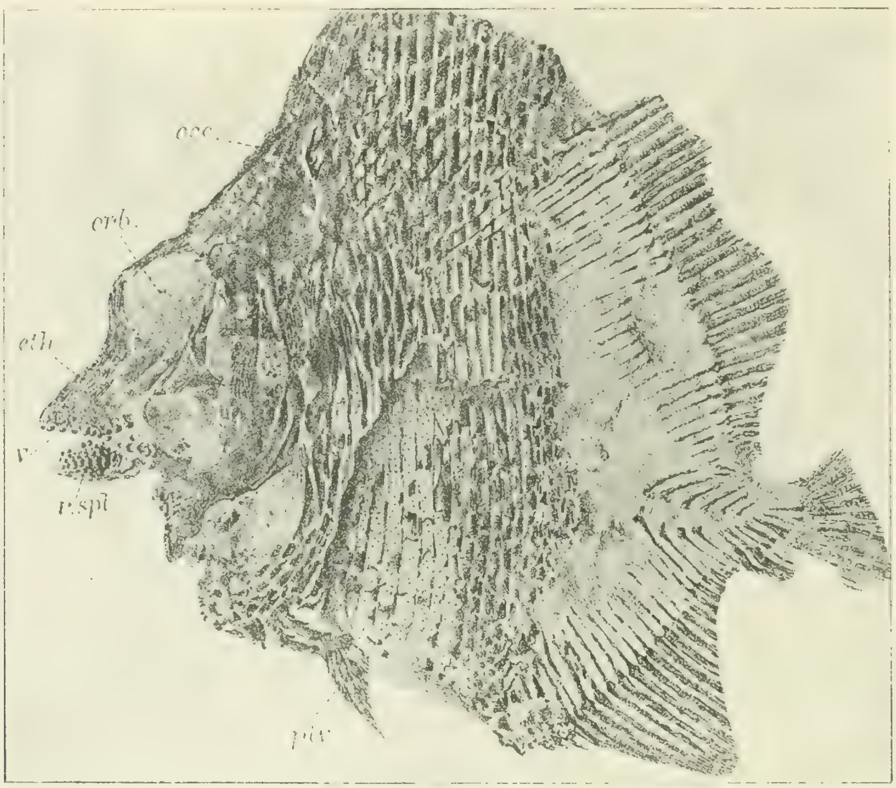


FIG. 22.—*Eomesodon barnesi,* A. S. Woodward; incomplete fish, two-thirds nat. size.—Portland Stone (Roach Bed); Portland, Dorset. *eth.*, mesethmoid; *occ.*, supraoccipital; *orb.*, orbit; *plv.*, pelvic fin; *r.spl.*, right splenial; *v.*, vomer. F. J. Barnes Collection.

of trunk about equalling the total length of the fish to the base of the caudal fin. Teeth smooth, a few of those of the lateral series having a faint apical pit with traces of crimping on the border; splenial teeth closely arranged, those of the principal series broader than long, flanked within by one row of small round teeth and externally by three series, of which the median is the smallest, and the outer about equal in size to the inner series. Dorsal fin with about 30, anal fin with about 20 rays. Granulation of external bones and scales coarse; enamelled denticles few and conspicuous on dorsal and ventral ridge-scales.

Description of Purbeckian Specimen.—The type specimen (Text-fig. 22) was obtained by the late Mr. F. J. Barnes, F.G.S., from the roach bed of the Portland Stone at Portland. The occurrence of the species in the Purbeck Beds is uncertain, but an imperfect specimen in the British Museum seems to agree with it in the parts which are comparable. This fossil (Pl. XIII, fig. 1), which is not much more than half as large as the type, is of approximately similar proportions, but lacks entirely the upper part of the head, the paired fins, and the caudal fin. The external bones and scales are ornamented with very prominent large hollow tubercles. The orbit is relatively large, and the cleft of the mouth small; and some of the lateral vomerine teeth are crimped round the shallow apical pit. As shown in broken section the bones are of very open texture. The typical rather stout neural and hæmal arches of the axial skeleton, with traces of their laminar expansions, are seen in the caudal region. The fragmentary dorsal and anal fins have clearly about 30 and 20 supports respectively, while all the rays are very stout, closely articulated, and subdivided distally. Some of the anterior rays of the anal fin are armed with rows of very small and slender, slightly arched denticles (fig. 1 *c*, *a.*). The squamation on the large and deep abdominal region is shown chiefly in impression, but a few actual remains of scales above the position of the notochord bear traces of the canal for the lateral line. The number of complete transverse series of scales cannot have been less than 20; and the scales, being less deepened, seem to have been more numerous in each series than in the typical *Mesodon*. Fragments of the dorsal ridge-scales bear very stout large smooth denticles (figs. 1 *a*, 1 *b*), and the ventral ridge-scales have these denticles still larger, each of the scales just in front of the anal fin bearing only one denticle with a boss in front (fig. 1 *c*).

Horizons and Localities.—Portland Stone (Roach Bed): Isle of Portland. (?) Middle Purbeck Beds: Swanage, Dorset.

2. **Eomesodon depressus,** sp. nov. Plate XIII, fig. 2.

Type.—Fragment of head and trunk; British Museum.

Specific Characters.—Elevation of back steep in front, but gradually descending to the rather remote dorsal fin; most of the dorsal ridge-scales bearing eight small denticles which are nearly uniform in size.

Description of Specimen.—Though well distinguished by the characters of the dorsal ridge, this species is known only by the fragmentary type specimen (Pl. XIII, fig. 2) which was discovered by the late Mr. Frederick Hovenden, F.G.S. The orbit (*orb.*) and the postorbital part of the skull are vaguely indicated, and the steep anterior profile of the fish does not appear to have been distorted. The very coarse tuberculation is visible on the fragments of head-bones preserved.

The axial skeleton of the trunk is nearly complete, comprising slightly more than 30 arches, of which about a third are caudal. Traces of the laminar expansions are seen both on the neural and the hæmal spines. A few of the dorsal fin-supports (*d.*) occur just behind the abdominal squamation, but no other remains of the fins are preserved. The scales are in slightly more than 20 regular transverse series, and exhibit both their internal and their external characters. The peg-and-socket articulation is very deep on all the scales, but the internal riblet is largest on the scales of the lower part of the abdominal region (fig. 2 *c*). Each scale is deeply overlapped in front, and its exposed portion is covered with large tubercles of ganoine (fig. 2 *b*). Each dorsal ridge-scale (fig. 2 *a*) is also provided along the middle line with a row of eight smooth conical denticles, which are nearly equal in size. The next row of scales below the dorsal ridge is traversed as usual by a slime-canal, and the lateral line is traceable along the middle of the flank. The number of scales in each transverse series is uncertain, but there seems to be about nine above the lateral line.

Horizon and Locality.—Middle Purbeck Beds: Swanage, Dorset.

Addendum.—Detached jaws of *Mesodon* and *Eomesodon* are not uncommon in the Purbeck Beds, but it is still not possible to name them specifically. The left splenial dentition shown in Pl. XIII, fig. 3, is remarkable for the crowding of its principal teeth and the irregularity of its inner and outer small teeth. Another left splenial dentition (Pl. XIII, fig. 4) may probably be referred to *Mesodon* rather than to *Microdon* on account of its well-developed inner row of small teeth, though this feature is not absolutely distinctive.

Genus **MICRODON**, Agassiz.

Microdon, L. Agassiz, Poiss. Foss., vol. ii, pt. i, 1833, p, 16, and pt. ii, 1844, p. 204.

Generic Characters.—Trunk deeply fusiform or discoidal, with short slender caudal pedicle. Cranial shield without supratemporal vacuities. Head and opercular bones ornamented with reticulating rugæ and pittings; two chisel-shaped teeth in each premaxilla and dentary; tritoral teeth smooth, sometimes feebly indented in the lateral series; vomerine teeth in five longitudinal series, but the inner lateral pairs regularly alternating with the widely spaced median teeth; splenial teeth in four series, the innermost being relatively small, the second the largest or principal series. Neural and hæmal arches of axial skeleton of trunk not expanding sufficiently to encircle the notochord. Fin-rays robust, articulated, and much divided distally. Pelvic fins present; dorsal and anal fins high and acuminate in front, rapidly becoming low and fringe-like behind, the former occupying at least the hinder half of the back, and the latter somewhat shorter, arising more posteriorly; caudal fin forked. Scales ornamented with reticulated

rugæ or pittings, covering only the anterior half of the trunk, and complete only in the lower part of the flank; traces of riblets of scales sometimes on the middle of the flank of the caudal region.

Type Species.—Microdon elegans (L. Agassiz, Poiss. Foss., vol. ii, pt. i, 1833, p. 16, and pt. ii, 1839–44, p. 205, pl. lxix *b*) from the Lower Kimmeridgian (Lithographic Stone) of Solenhofen, Bavaria.

1. **Microdon radiatus,** Agassiz. Plate XIV; Plate XV, figs. 1—5; Text-figure 23.

1839–44. *Microdon radiatus,* L. Agassiz, Poiss. Foss., vol. ii, pt. ii, p. 208, pl. lxix *c*, figs. 1, 2.
1840. *Microdon radiatus.* R. Owen, Odontography, p. 73, pl. xliii, fig. 1 [microscopical structure of teeth].
1895. *Microdon radiatus,* A. S. Woodward, Catal. Foss. Fishes Brit. Mus., pt. iii, p. 223.

Type.—Imperfect fish.

Specific Characters.—A species attaining a length of about 12 cm. Maximum depth of trunk somewhat less than total length to base of caudal fin; head with opercular apparatus occupying scarcely a quarter of total length of fish. Splenial teeth of principal series with well-rounded ends, wider than the two outer series, of which the outermost is considerably the larger. Vertebral axis at origin of dorsal fin slightly above middle line of trunk. Dorsal fin with about 40, anal fin with 30 supports. Each ridge-scale with three or four very prominent denticles, inclined and increasing in size backwards, flank-scales delicate, marked with more or less radiating rugæ between the pittings.

Description of Specimens.—The type specimen, originally in the collection of H. E. Strickland, exhibits the general proportions of the fish, with the characteristic stout ventral ridge-scales, but somewhat distorted in the region of the pectoral arch and lacking the greater part of the fins except the caudal. A smaller specimen in the Dorset County Museum (Pl. XIV, fig. 1) shows still better the shape of the fish as noted in the specific diagnosis above; while a larger specimen in the British Museum (Pl. XIV, fig. 2) displays the principal characters of the trunk.

In the skull (Pl. XV, fig. 1) the facial region as usual is somewhat bent downwards, while the tooth-bearing surface of the vomer is in a plane nearly parallel to that of the base of the cranium. The cranial cartilage is well ossified, one specimen in the British Museum (no. P. 1627 *a*) showing apparently the exoccipital, basioccipital, and pro-otic elements, while others seem to exhibit a postfrontal (sphenotic) and perhaps an alisphenoid or orbitosphenoid (Pl. XV, fig. 1, *ors.*). The cranial roof is completely covered with membrane bones, which are marked with a more or less radiating reticular ornament. A small narrow median element which forms the crest behind the frontals, may be described as the supraoccipital plate (Pl. XV, fig. 1, *socc.*), and bears a few close rows of small recurved denticles along its edge. It is more or less incompletely fused behind with the first ridge-

scale (*r.s.*), which bears a median row of three or four recurved denticles rapidly increasing in size backwards. The lateral wings of this ridge-scale taper downwards as they pass below the limit of the supraoccipital plate. A relatively large parietal (*pa.*) bounds the supraoccipital outwardly or below, and tends also to bound the squamosal behind. It may even be interpreted as consisting of the parietal fused with a narrow supratemporal, for it is crossed by two sparse transverse rows of large openings which mark the course of slime-canals, while a long smooth digitate prominence (*x.*) from the middle of its hinder border may be a post-temporal. The shape of the bone and its reticulate ornament are well shown in an isolated specimen (Pl. XIV, fig. 4) which has unfortunately been drawn upside down. The squamosal bone, which has slipped a little beneath the parietal

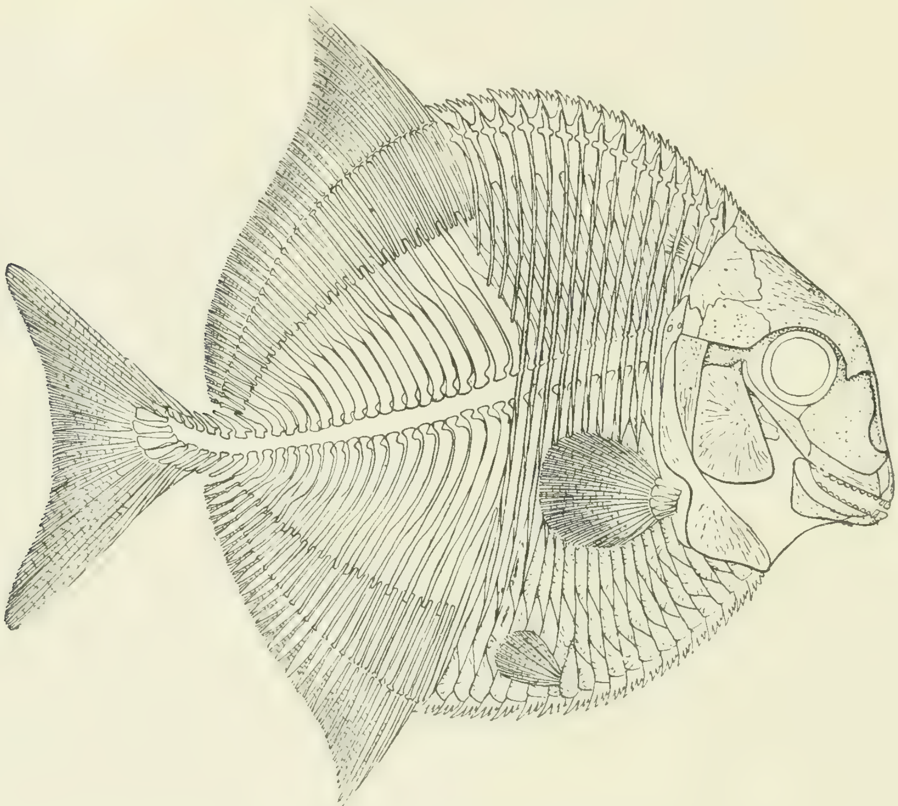


FIG. 23.—*Microdon radiatus*, Agassiz; restoration (omitting pterygo-quadrate arch), nearly nat. size.—Middle Purbeck Beds; Swanage, Dorset.

in the original of Pl. XV, fig. 1 (*sq.*), is relatively small, with its maximum width not quite equalling its maximum length. It forms the upper part of the posterior border of the orbit and completely covers the postfrontal (sphenotic). The frontals (*fr.*) are by far the largest bones of the cranial roof, widely expanded in their rather flat hinder region, tumid above the front of the orbit where they bend sharply downwards, and truncated anteriorly where they end above the middle of the anterior border of the orbit. The course of the longitudinal slime-canal is

marked on their outer face by a sparse series of large openings. No superficial bones have been clearly observed in advance of the frontals covering the narrow ethmoidal region, which seems to consist of a single vertical mesethmoidal plate (*me.*) with a thickened anterior margin, which is expanded into a rounded lobe on each side in the lower half. This element is triangular in shape, ending abruptly behind within the anterior third of the orbit, and bounded below by the parasphenoid and vomer, which extend along its posterior and its anterior portion respectively. The parasphenoid (*pas.*) is relatively large, but its hinder portion beneath the cranium is obscure in all the fossils. Where crossing the orbit the bone is slender, but it bears a thin laminar vertical keel (*k.*) below, with a free wing extending forwards to the hinder border of the mesethmoid region. Where it underlies the mesethmoid in front it also expands above into a low thin vertical lamina. The single vomer (*vo.*) is widened at its oral face to support the dentition, and its upper median keel for union with the mesethmoid is low, while it extends only slightly further forwards than the latter element. No cheek-plates have been observed, but there are often traces of an ossified sclerotic ring (Pl. XIV, fig. 1).

The mandibular suspensorium is much inclined forwards to the small obliquely-cleft mouth. The hyomandibular (Pl. XIV, fig. 10, *hm.*) is a deep narrow lamina of bone, slightly curved forwards on its long axis, with a rounded expansion behind in its upper part for the support of the operculum. Its outer face in the upper half is strengthened by a curved longitudinal ridge with its concavity forwards. The quadrate and the pterygo-palatine have not been observed, but must have been comparatively delicate plates. The nature of the maxilla, if present, remains uncertain, but there are sometimes traces of a thin toothless bone flanking the vomer, which may represent a maxillary element (*e.g.*, Mus. Pract. Geol. no. 28352, and B.M. no. 44844). The premaxilla (Pl. XIV, fig. 1) is a long slender rod tapering upwards, gently arched forwards to leave a gap between itself, the vomer, and the mesethmoid, and in contact with the latter at its upper end. Its oral border bears two smooth chisel-shaped teeth, of which the inner is the larger; while its posterior or outer border seems to be notched where there may have been the narial opening. The reduced dentary bone (Pl. XIV, fig. 6) closely resembles the premaxilla in size and shape, but its two smooth chisel-shaped teeth are relatively larger. The inner of the two teeth is again the larger. This bone (Pl. XIV, fig. 3, *d.*) rests as a splint along the front margin of the splenial which forms the greater part of the mandibular ramus. The latter stout tooth-bearing bone is exposed as a wide smooth band on the outer face of the jaw below the oral border (*spl.*); and its hollowed lower portion, which would be occupied by the meckelian cartilage, is covered for the greater part of its extent by a large elongate-triangular angular plate (*ag.*).

The tritoral teeth of the vomer and splenial bones are smooth, and when unworn usually exhibit a shallow apical pit, of which the margin may be slightly

crenulated (Brit. Mus. no. P. 1627 *b*). They are all closely arranged, and are often much worn by mastication. The vomerine dentition is only incompletely seen in the skeletons, but there can be little doubt that the large isolated example shown enlarged in Pl. XIV, fig. 5, belongs to *Microdon radiatus*. Although this specimen is much worn it still retains traces of the apical pit in some teeth, and the oral surface is gently convex from side to side. The principal median teeth are slightly more than twice as wide as long, and the alternating inner paired teeth are relatively large. The outer paired teeth are smaller and very irregular both in size and shape. The splenial dentition is well displayed in two skeletons in the British Museum (Pl. XIV, figs. 7, 8), both much worn, but retaining traces of the apical pits in the outer or lateral teeth. The principal teeth are at least as wide as the two outer series together, and the inner series of small teeth is always imperfectly developed. The teeth of the outermost series are wider than long, and much larger than those of the next series. The microscopical structure of the tritoral teeth has already been described by Owen ('Odontography,' 1840, p. 73, pl. xliii, fig. 1). Each tooth has a large pulp-cavity from which numerous very fine tubuli radiate into the ordinary dentine as far as the thick superficial layer of ganodentine.

The hyoid arch is comparatively small, and does not bear any branchiostegal rays. The epihyal (Pl. XIV, fig. 9, *eph.*) is about half as long as the ceratohyal (*ch.*), which is deepened behind and much constricted in front.

The opercular apparatus comprises solely a large preoperculum and a smaller operculum. The preoperculum, usually crushed as shown in Pl. XIV, fig. 1, is irregularly triangular in shape with a truncated apex, the maximum width of its base considerably exceeding half its depth. It is more or less firmly united to the hyomandibular, which the truncation of its apex leaves exposed (or possibly covered by a separate plate) at its upper end. Its outer face is ornamented by reticulating ridges which radiate from the middle of its anterior border; and the usual slime-canal, which traverses the anterior half of the bone, is marked in its upper portion by a slight groove, in its lower portion by a few irregularly spaced pores. The operculum (Pl. XIV, fig. 10, *op.*) is also approximately triangular in shape, but widest at its upper end and from three to four times as deep as wide. Its upper limit corresponds with that of the hyomandibular, and the ornamental reticulations on the outer face radiate from its point of suspension. When the opercular bones are removed, traces of calcified gill-supports are sometimes seen.

The vacant space for the notochord runs in a slightly sinuous curve somewhat above the middle of the trunk, and the bounding arches must have been more or less firmly united, as shown by their usually undisturbed relations in the fossils. Their triangular proximal expansions are much too small to encircle the notochord, but their characteristic anterior laminar appendages are sufficiently wide to fill at least the proximal half of the spaces between them. A few of the anterior neural

spines are comparatively stout and radiating, but the other neurals, as also the hæmals in the caudal region, are nearly parallel, and the only thickening occurs again in the short hæmals at the base of the tail. None of these arches reach the dorsal or ventral border of the fish. The ribs, which are usually obscured by the overlying squamation, are also stout and bear the laminar appendages or expansions, which are especially wide in the foremost of the series (Pl. XIV, fig. 3, *r.*). Like the other arches, the ribs do not extend to the ventral border. The total number of vertebral arches is about 15 in the abdominal, 20 in the caudal region.

In the pectoral arch two membrane bones are conspicuous. The clavicle is relatively large, extending in a gentle sigmoid curve from the level of the notochordal axis to the ventral border. It is constricted at the origin of the pectoral fin, the upper part being narrow and tapering upwards, the lower part forming a large spatulate expansion, bluntly pointed below. Its smooth inner face (Pl. XIV, fig. 2, *cl.*) is concave, while its flat or slightly convex outer face (Pl. XIV, fig. 1) is marked by a feeble reticular ornament. The anterior border of its exposed sigmoidal portion seems to bear a smooth delicate laminar expansion, partly shown in Pl. XIV, fig. 2, but better seen in Brit. Mus. no. 44844. The supraclavicle (Pl. XIV, fig. 10, *scl.*) is a deep and narrow bone crossed as usual at its upper end by the slime-canal of the lateral line. It is widest and thickest superiorly where a triangular area with a postero-inferior extension is exposed and marked with a reticulate ornament. Its lower covered portion tapers to a slender point. The cartilages of the pectoral arch are unknown, but the pectoral fin is lobate and supported by a few long and stout hour-glass-shaped basals (Pl. XIV, fig. 1). Its rays are also broad and closely subdivided. The pelvic fins, of which one is seen slightly displaced in Pl. XIV, fig. 2, *plv.*, are relatively small, inserted about midway between the pectorals and the anal, and comprise five or six very broad rays which are articulated and subdivided. The rays of the median fins are also rather broad, with numerous articulations and some subdivision. There are slightly more than 40 rays in the dorsal fin, slightly more than 30 rays in the anal fin, and in both cases the few foremost supports are the longest and most crowded to bear the long anterior rays. Unfortunately these fins are not well seen in any known specimen. The characteristic forked caudal fin, with its constricted pedicle, is well shown in Pl. XV, fig. 2. A few of its foremost basal rays both above and below are in the form of long and slender uniserial fulcra, but most of its rays, about 18 in number, are articulated with step-shaped joints and also subdivided distally. All the fin-rays are smooth.

The peculiar rod-shaped bone apparently bounding the abdominal cavity behind (noticed in Catal. Foss. Fishes Brit. Mus., pt. iii, p. 196) is sometimes recognisable above the hindmost ventral ridge-scale (Pl. XIV, fig. 1, *x.*).

As shown by the ridge-scales, the total number of transverse series of scales covering the abdominal region is about 16, but they are represented for the greater

part of their extent solely by the thickened anterior rim. The ridge-scales, which are arranged in a regular close series, are much thickened, and each bears a row of three large, hollow, smooth denticles increasing in size backwards, sometimes with an additional one or two minute denticles in front. The massive smooth ridge-scales of the ventral border exhibit wide facettes for overlap by the lowest flank-scales (Pl. XIV, figs. 1 *b*, 2); while each of those of the dorsal border is produced downwards into a triangular lateral wing, which is more or less ornamented by reticulations like the other scales. The flank-scales are complete only in the lower part of the abdominal region, diminishing in number and vertical extent backwards. As shown by a specimen from Ridgeway, in the Dorset County Museum, there are five of these scales in at least one anterior transverse series, four scales in several following series, then three scales, and finally only two complete scales in at least one series adjacent to the origin of the anal fin. All these scales (Pl. XV, fig. 3) are much deeper than wide, increasing in depth upwards, and the uppermost scale ends in an attenuated apex. The line of union between each scale and the next above is very oblique, and the posterior border is gently convex. The outer surface is ornamented with reticulations which tend to radiate from the middle of the smooth anterior margin. This margin has a wide thickening on the inner face, which forms the usual deep peg-and-socket articulation (Pl. XV, figs. 4, 5). At the position of the pelvic fins, which are inserted in a triangular hollow on the flank just above the ventral border, the lowest scales of two transverse series diverge to allow the intercalation of a deep triangular scale, and one of the ridge-scales is extended to bear a second facette for the overlap of this additional scale (as shown in Pl. XIV, fig. 2, *dr.*). The lateral line passes through a perforation in the degenerate riblet of at least the two anterior series of scales; and all the riblets immediately below the dorsal ridge-scales are slightly widened and pierced along the course of the upper lateral line. A single smooth, nearly rhombic scale is also sometimes seen at the base of the caudal fin, perhaps the last remnant of the squamation of an upper caudal lobe.

The principal characters of the species, as now described, are shown in the restoration of the fish, Text-fig. 23, p. 60.

Horizon and Localities.—Middle Purbeck Beds: Swanage and neighbourhood of Weymouth, Dorset.

Genus **CŒLODUS**, Heckel.

Cœlodus, J. J. Heckel, Sitzungsb. k. Akad. Wiss. Wien, math.-naturw. Cl., vol. xii, 1854, p. 455.
Glossodus, O. G. Costa (*non* McCoy, 1848), Atti Accad. Pontan., vol. vii, 1853, p. 26.
Cosmodus, H. E. Sauvage, Bull. Soc. Sci. Nat. Yonne, vol. xxxiii, pt. ii, 1879, p. 48.

Generic Characters.—Trunk deeply fusiform, with short slender caudal pedicle. Cranial roof-bones pierced by a pair of supratemporal vacuities, surrounded by the supraoccipital, parietal, and frontal elements. Head and opercular bones externally rugose and punctate; two chisel-shaped teeth in each premaxilla and dentary; tritoral teeth often exhibiting an apical indent usually with crenulated border; oral surface of vomer convex from side to side, with teeth in five longitudinal series; splenial dentition comprising three series of teeth with long axes more or less directly transverse, sometimes supplemented within by a small row. Neural and hæmal arches of axial skeleton of trunk not expanding sufficiently to encircle the

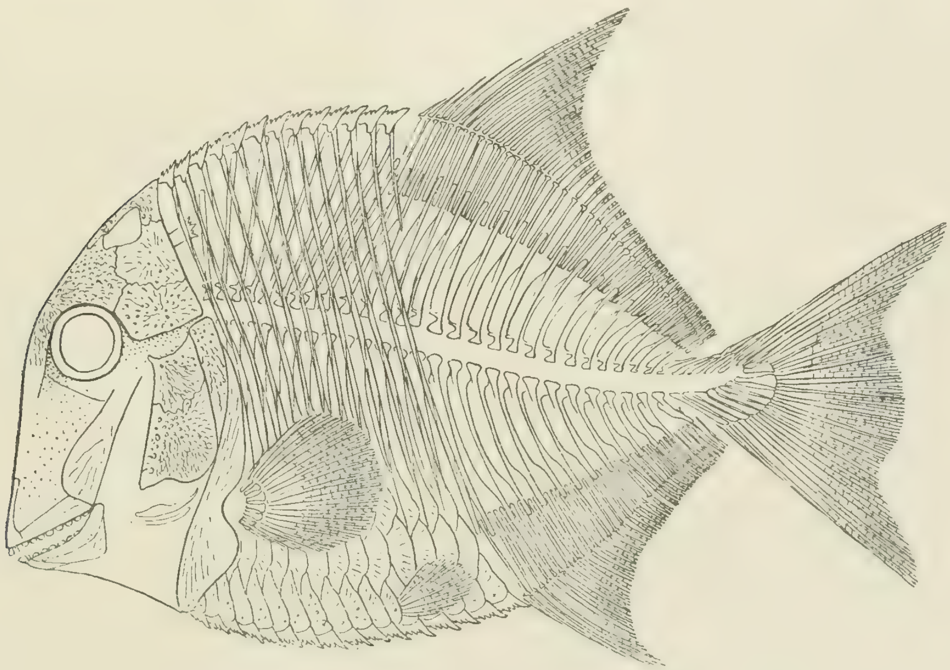


FIG. 24.—*Cœlodus costæ*, Heckel; restoration (omitting pterygo-quadrate arch), nearly nat. size.—Lower Cretaceous; Torre d'Orlando,Castellamare, Naples.

notochord. Fin-rays robust, closely articulated, and much divided distally. Pelvic fins present; dorsal and anal fins high and acuminate in front, low and fringe-like behind, the former occupying at least the hinder half of the back, and the latter somewhat shorter, arising more posteriorly; caudal fin forked, with a convexity in the middle. Scales ornamented with reticulating rugæ and punctations, occupying only the anterior half of the trunk in advance of the median fins, and complete only in the ventral region.

Type Species.—*Cœlodus saturnus* (Heckel, *loc. cit.*, 1854, p. 455, and Denkschr. k. Akad. Wiss. Wien, math.-naturw. Cl., vol. xi, 1856, p. 207, pls. iii, iv), known by a nearly complete fish from the Lower Cretaceous of Goriansk, Istria.

Remarks.—This is typically a Cretaceous genus and is known by several complete skeletons; but only jaws have hitherto been found in the Wealden and

Purbeck formations. The dentition is so variable that such fossils can only be provisionally named.

A restoration of the skeleton of a small species, *Cœlodus costæ*, based partly on specimens in the British Museum (nos. P. 1671, P. 1671 *a*, P. 4394), partly on figures by Bassani and D'Erasmo,[1] is given in Text-fig. 24.

1. **Cœlodus mantelli** (Agassiz). Plate XV, figs. 6—11.

1827. "Palates of an unknown fish," G. A. Mantell, Foss. Tilgate Forest, p. 58, pl. xvii, figs. 26, 27.
1833. *Pycnodus microdon*, L. Agassiz, Poiss. Foss., vol. ii, pt. i, p. 17.
1839–44. *Pycnodus mantellii*, L. Agassiz, *tom. cit.*, pt. ii, p. 196, pl. lxxii *a*, figs. 6—14.
1839–44. *Gyrodus mantellii*, L. Agassiz, *tom. cit.*, pt. ii, p. 234, pl. lxix *a*, fig. 18.
1853. *Glossodus mantellii*, O. G. Costa, Atti Accad. Pontan., vol. vii, p. 28.
1856. *Cœlodus mantelli*, J. J. Heckel, Denkschr. k. Akad. Wiss., math.-naturw. Cl., vol. xi, p. 203.
1895. *Cœlodus mantelli*, A. S. Woodward, Catal. Foss. Fishes B.M., pt. iii, p. 252.

Type.—Jaws; British Museum.

Specific Characters.—A species of small or moderate size known only by the jaws and dentition which rarely exceed 2 cm. in length. All teeth smooth, with a shallow apical pit, which in unworn specimens is faintly crenulated round the margin. Teeth of median series on vomer somewhat more than twice as broad as long, with a concave posterior margin, sometimes mesially constricted; teeth of two lateral series nearly equal in size, often slightly elongated antero-posteriorly, their width together not equalling that of the median series. Teeth of principal series on the splenial bone about twice as broad as long, scarcely tapering inwards, slightly raised at their outer end; their width scarcely equalling that of the two outer series, of which the innermost is nearly twice as wide as the outermost; the inner of these teeth more or less raised at the inner end; a series within the principal series rarely represented even by scattered small teeth. Initial anterior end of splenial narrow, with the teeth in three regular series.

Description of Specimens.—The original portions of dentition in the Mantell Collection, described by Agassiz, are rightly identified as belonging both to the vomerine and splenial bones, and exhibit most of the principal characters of the species. One specimen showing the narrow splenial dentition of a young individual, with three regular series of teeth, is also described under the name of *Gyrodus mantellii*. All these fossils were obtained from the Wealden (presumably Tunbridge Wells Sands) of Tilgate Forest, Sussex.

The largest known specimen of the vomerine dentition, already figured by Agassiz, *tom. cit.*, pl. lxxii *a*, fig. 12, is shown enlarged in Pl. XV, figs. 6, 6 *a–c*. The median teeth are well spaced and all are worn by mastication except the

[1] F. Bassani and G. D'Erasmo, "La Ittiofauna del Calcare Cretacico di Capo d'Orlando presso Castellammara (Napoli)," Mem. Soc. Ital. Sci. [3], vol. xvii (1912), pl. v, figs. 4, 5.

hindmost, which displays its median constriction, raised ends, and the transversely elongated apical pit with a crenulated anterior rim. To the left the lateral teeth are covered by hard matrix, but on the right side (fig. 6 *a*) both series are well seen, with traces of small intercalated teeth in front; all probably had an apical pit, but they are so much worn that only the hindmost tooth of the outer series retains the crenulated rim. The teeth in smaller examples of the vomerine dentition have a larger and deeper apical pit with crenulated margin; but the specimens are usually so much worn by mastication and accidentally flaked in the fossils, that this feature is often obscured. In many cases the wearing of the teeth reaches the pulp-cavity, and in one specimen figured by Agassiz (*tom. cit.*, pl. lxxii *a*, fig. 13) only the broken bases of insertion are seen on the bone.

In specimens of the adult splenial dentition, as in one figured by Agassiz (*tom. cit.*, pl. lxxii *a*, fig. 14) and in the original of Pl. XV, fig. 7, the anterior tapering end is usually broken away; but some of the immature stages represented by this end are shown in Pl. XV, figs. 8—11. The smallest of these specimens (fig. 9) was wrongly referred by Agassiz (*loc. cit.*) to the upper jaw of *Gyrodus*, under the name of *G. mantellii*. It is a left splenial bone, of which the inner margin is recognisable in the matrix, and it exhibits the three characteristic regular rows of teeth, each with a large apical pit which has been more or less reduced by wear. A larger left splenial (fig. 10) bears teeth which are not only much worn but also a little flaked. The third small splenial dentition (fig. 8) has already been figured by Agassiz (*tom. cit.*, pl. lxxii *a*, fig. 11), and is interesting as still retaining the crenulations round the margin of the apical pit in the hinder teeth. The fourth specimen (fig. 11), which is detached from the matrix, shows well (fig. 11 *a*) the depth of the groove in the dental armature formed by the lateral teeth, and the extreme wear in the front part of this groove. Several small examples of the dentition from the Wealden (presumably Weald Clay) of Sevenoaks, Kent, in the Museum of Practical Geology, are interesting both for the fine unworn condition of many of the teeth and for the irregular subdivision of some others.

Horizons and Localities.—Wealden: Tilgate Forest, Tunbridge Wells, and Hastings, Sussex; Atherfield, Isle of Wight; Sevenoaks, Kent. Lower Wealden or Upper Purbeck: Netherfield, Sussex.

2. **Cœlodus multidens,** sp. nov. Plate XV, figs. 12, 13.

Type.—Splenial bone; Museum of Practical Geology, London.

Specific Characters.—Initial anterior end of splenial bone wider than in *C. mantelli*, covered with an irregular group of smooth rounded teeth, each with an apical pit; mature splenial teeth almost as in *C. mantelli*, but apical pit apparently shallower.

Description of Specimens.—This species is known only by the splenial bone, of which the anterior part bears teeth like those of *Athrodon*. The normal dentition does not begin until the bone has attained a width of at least a centimetre. The type specimen (Pl. XV, fig. 12) exhibits the short and broad bone with a wide inner border free from teeth. The irregular teeth occupy more than half of its length, but the hinder teeth are almost exactly those of *Cœlodus mantelli*. All are much worn except the two teeth most posteriorly, which are not crimped round the shallow apical pit. In part of a smaller specimen (Pl. XV, fig. 13) the teeth are extremely worn by mastication, and the principal teeth are inclined at a considerable angle to those of the outer series.

Horizon and Localities.—Wealden: Sevenoaks, Kent; Battle, Sussex; Brook and Atherfield, Isle of Wight.

3. **Cœlodus hirudo** (Agassiz). Plate XV, figs. 14—18.

1839. *Acrodus hirudo*, L. Agassiz, Poiss. Foss., vol. iii, p. 148, pl. xxii, fig. 27.
1887. ,, ,, A. S. Woodward, Geol. Mag. [3], vol. iv, p. 102.
1889. ,, ,, A. S. Woodward, Catal. Foss. Fishes B. M., pt. i, p. 296, pl. xiii, fig. 9.

Type.—Much worn tooth; British Museum.

Specific Characters.—A species known only by isolated dental crowns which sometimes attain a length of 2·5 cm. in longest diameter, but are usually smaller. Principal teeth slightly more than twice as broad as long; coronal contour gently rounded, somewhat raised near each lateral end, and the surface marked by very fine wrinkles diverging or radiating from an extended apical pit which is reduced to an inconspicuous groove.

Description of Specimens.—The type specimen, which was misunderstood by Agassiz, is shown from the upper, anterior, and lateral aspects in Pl. XV, figs. 14, 14 *a*, *b*, and may be regarded as a principal tooth of the left splenial bone. It is imperfect at the outer and posterior borders, and its upper surface (fig. 14) has been removed by mastication, which has produced a deep hollow in the outer half. The posterior broken edge shows that the main part of the tooth consists only of a comparatively thin crown, without any root. The anterior face (fig. 14 *a*), which is described and figured by Agassiz as the top of the crown, retains the characteristic ornament of very fine vertical wrinkles. Concentric lines of growth are conspicuous round the base of the crown, which is shown to have been fixed to the bone by a peripheral root in the usual Pycnodont manner.

A smaller tooth evidently of the same type was described and figured *loc. cit.* 1889, displaying the shape and ornament of the unworn crown; and another good pecimen of intermediate size is shown in Pl. XV, figs. 15, 15 *a*, *b*. Here the oral surface (fig. 15) is only slightly worn, so that the original contour of the tooth is

obvious. The anterior as well as the posterior face (fig. 15 *a*) exhibits traces of concentric lines of growth across the characteristic wrinkled ornament, and the peripheral nature of the root is clear (figs. 15 *a*, *b*). A smaller specimen (fig. 16) shows well the remnant of the apical pit as a slight fissure from which the coronal wrinkles diverge.

The lateral teeth have not been identified with certainty, but the low-crowned ovoid specimen represented in Pl. XV, fig. 17, may be one of them. The peripheral ornament of the crown resembles that of the principal teeth of this species, but that of the middle of the crown is a coarse irregular tuberculation. Among other teeth that are evidently Pycnodont, the small elongated specimen with a high crown shown in Pl. XV, fig. 18, may also belong to one of the lateral series of *C. hirudo.*

A microscopical section made from one of the principal teeth exhibits the typical Pycnodont structure, densely arranged minute tubuli traversing the dentine from the pulp-cavity direct to the superficial ganodentine.

Horizon and Localities.—Wealden: Tilgate Forest; neighbourhood of Hastings (Wadhurst Clay and Ashdown Sands); Telham, near Battle.

4. **Cœlodus lævidens,** sp. nov. Plate XV, figs. 19, 20.

Type.—Splenial bone; British Museum.

Specific Characters.—A small species with splenial dentition usually not more than 2·5 cm. in length. Teeth of principal series on the splenial bone about twice as broad as long, scarcely tapering inwards and not much (if at all) raised at the outer end; surface smooth and apical pit absent or very shallow; the width equalling or somewhat exceeding that of the two flanking series. Teeth of inner flanking series also about twice as broad as long, only slightly raised at the inner end, smooth but with a deeper apical pit. Teeth of outer flanking series smaller, less transversely elongated, smooth but with shallow apical pit.

Description of Specimens.—The type specimen (Pl. XV, fig. 19) is the hinder part of a right splenial, of which the hindmost principal tooth is scarcely worn but still shows no more than the feeblest trace of an apical pit. The two hindmost flanking teeth, though pitted, are not crimped. The younger specimen of the left splenial shown in Pl. XV, fig. 20, is altogether similar, and bears the three rows of teeth in regular series to the anterior apex. Though in most respects resembling the corresponding dentition of *Cœlodus mantelli*, the absence of a well-defined apical pit in the principal teeth and the shape of the inner flanking teeth are characters suggesting that this form of jaw belongs to a distinct species.

A vomerine dentition closely similar to that of *C. mantelli* is known from the same horizon as the splenial just described, and probably belongs to this species.

Horizon and Locality.—Middle Purbeck Beds: Swanage, Dorset.

5. **Cœlodus arcuatus,** sp. nov. Plate XIII, fig. 5.

Type.—Vomerine dentition; Museum of Practical Geology, London.

Specific Characters.—A species known only by the vomerine dentition, which measures about 1·5 cm. in maximum width. Teeth of median series about three times as broad as long, much constricted mesially, and much arched backwards; apical pit well marked, crenulated round the margin, and the hinder face of the tooth vertically plicated in its concavity. Teeth of two lateral series nearly equal in size, and their width together not equalling that of the median series; apical pit well marked, large, and crenulated round the margin.

Description of Specimen.—The only known example of the vomerine dentition (Pl. XIII, fig. 5) is imperfect anteriorly but otherwise beautifully preserved. It exhibits the usual transverse convexity, but the teeth of the paired series are on a less steeply sloping surface than those in *C. mantelli.* The plication of the posterior concavity of the median teeth is especially characteristic of the species.

Horizon and Locality.—Middle Purbeck Beds: Swanage, Dorset.

Family Macrosemiidæ.

Genus **OPHIOPSIS,** Agassiz.

Ophiopsis, L. Agassiz, Neues Jahrb. f. Min., etc., 1834, p. 385; and Poiss. Foss., vol. ii, pt. i, 1844, p. 289.

Generic Characters.—Trunk much elongated, and the dorsal margin only slightly arcuate; head large or of moderate size. Marginal teeth acutely pointed. Notochord surrounded by delicate ring-vertebræ; ribs ossified. Bifurcation of dorsal fin-rays variable; fulcra present, comparatively stout at the base of the dorsal and caudal fins. Paired fins relatively large; dorsal fin ordinarily extending about half the length of the back, high in front, low behind; anal fin small and well forwards; caudal fin forked. Scales covering the whole of the trunk, in regular series, united by peg-and-socket articulation, and often pectinated at the hinder border; the scales of the middle of the flank scarcely deeper than broad, few of the ventral scales much broader than deep; no enlarged ridge-scales.

Type Species.—*Ophiopsis procera* (L. Agassiz, Poiss. Foss., vol. ii, pt. i, 1844, p. 289, pl. xlviii, fig. 1) from the Lower Kimmeridgian (Lithographic Stone) of Bavaria.

Remarks.—The restoration of the type species of *Ophiopsis* given in Text-fig. 25 is based chiefly on a specimen in the British Museum (no. P. 6939), in

which all the fins except the anal are nearly complete. In this fossil the ring-vertebræ are sufficiently stout not to have collapsed by crushing, and thus form a ridge beneath the squamation. The pectoral fin is strengthened at the base of its foremost ray by two or three large fulcra which rapidly increase in length backwards. The pelvic fin is relatively large and fringed with conspicuous fulcra. The dorsal fin, which rises to a sharp eminence in front, has five or six basal fulcra increasing in length ; and its fringing fulcra do not extend to the distal end of the foremost ray. The position of the very small anal fin is indicated, and this fin is restored from other specimens. The fork of the caudal fin is well shown. The large postclavicular scales are nearly smooth, but apparently serrated at their hinder border. Some of the anterior flank-scales are not only serrated, but also

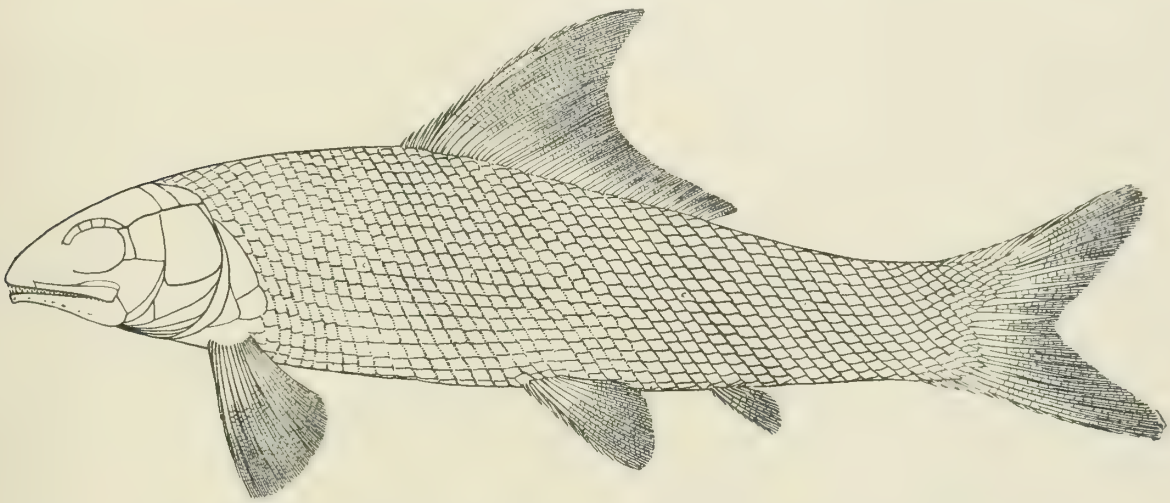


FIG. 25.—*Ophiopsis procera*, Agassiz; restoration, about two-thirds nat. size.—Lower Kimmeridgian (Lithographic Stone) ; Bavaria. Based chiefly on a specimen in the British Museum (no. P. 6939).

marked with pectinations extending from the serrations. The lateral line is inconspicuous, only indicated by an occasional short vertical slit or a postero-inferior notch on the scales which it traverses. Along the base of the dorsal fin, small irregular triangular scales are intercalated at the upper ends of the transverse series. The only enlarged ridge-scale is a flat oval scale at the beginning of the fulcral series on the dorsal border of the caudal pedicle.

1. **Ophiopsis penicillata,** Agassiz. Plate XVI, figs. 1, 2.

1844. *Ophiopsis penicillata*, L. Agassiz, Poiss. Foss., vol. ii, pt. i, p. 290, pl. xxxvi, figs. 2—4.
1895. *Ophiopsis penicillata*, A. S. Woodward, Catal. Foss. Fishes B.M., pt. iii, p. 169.

Type.—Nearly complete fish ; British Museum.

Specific Characters.—A robust species about 18 cm. in length. Length of head

with opercular apparatus somewhat exceeding maximum depth of trunk, which is twice as great as depth of caudal pedicle and contained about five times in total length of fish. External head-bones coarsely tuberculated or rugose; marginal teeth long and slender. Dorsal fin arising at the end of the anterior third of the back, half as long as the trunk, comprising not less than 25 rays, mostly bifurcated, of which the longest do not equal the depth of the trunk at their point of insertion; pelvic fins arising slightly in advance of the middle point between the pectorals and the caudal. Scales smooth, with finely serrated hinder border except towards the hinder end of the caudal region where they are entirely smooth.

Description of Specimens.—The type specimen (Pl. XVI, fig. 1) is contained in Purbeck stone of uncertain origin, and exhibits most of the specific characters of the fish. Though not much distorted, it is considerably fractured by crushing; and it is represented in a rather diagrammatic manner in the original drawing published by Agassiz. The head is probably not lengthened by distortion, but the cranial roof is pushed over to the left side, so that the right squamosal and some other bones are seen from below. One fragment of bone displays the coarse ornament of tubercles of ganoine, which are partially fused together. Slender styliform teeth, with a sharply pointed and somewhat incurved apex (fig. 1 *a*), occur in both jaws. The left operculum, exposed from within, is about two-thirds as wide as deep. Below it are the comparatively small suboperculum and interoperculum, and some remains of branchiostegal rays. Above it may be recognised the left side of the pair of supratemporal plates, and a much larger post-temporal which is in contact with an elongated supraclavicle, passing below to the much-arched smooth clavicle. The axial skeleton of the trunk must have been imperfectly ossified, but there are traces of vertebral centra and stout neural arches just behind the occiput, and more distinct remains (though not so clear as figured by Agassiz) also occur in the hinder half of the tail. The caudal vertebral rings seem to have been longer than deep, with stout neural and hæmal arches; and the upturned end of the vertebral axis is distinct. The two pectoral fins are crushed together, each probably consisting of about twelve rays, which are closely articulated and bifurcating in more than their distal half. They do not exhibit fulcra. The pelvic fins, also crushed together, are much smaller, and seem to bear a few slender fulcra. The extended dorsal fin shows about five basal fulcra in front, and its well-spaced stout rays are all articulated and bifurcated distally. The complete length of its anterior rays seems to be exhibited. The anal fin is represented by a mere fragment, with some of its supports. The large and strong caudal fin, with slender fulcra along its upper border, must have been forked. The greater part of the squamation of the left side is undisturbed and exposed from its inner face, while traces of the scales of the right side, in outer view, are seen near the ventral margin. There are enlarged post-clavicular scales, at least just above the insertion of the pectoral fin. None of the flank-scales seem to have been deeper than broad,

most of the scales being broader than deep, and those near the ventral border especially so. On all the scales the inner vertical rib is feebly marked and wide, and in the principal scales (fig. 1 *b*) the peg-and-socket articulation behind this rib is wide and shallow. The caudal scales (fig. 1 *c*) are not united by peg-and-socket. In the abdominal region the lateral line traverses about the eighth row from the dorsal, the twelfth or thirteenth row from the ventral border. The exhibited outer face of the ventral scales is smooth and slightly concave, and the hinder margin seems to have been feebly serrated. There are no enlarged ridge-scales.

A more imperfect and slightly larger specimen obtained by Mr. R. F. Damon from the Purbeck Beds of the Isle of Portland (Brit. Mus. no. P. 8375), evidently belongs to the same species and shows a few additional features. The premaxilla, as usual in *Ophiopsis*, is relatively large and much expanded. The vertebræ in the abdominal region are complete cylinders about as long as deep, and the short ribs are remarkably slender. Each of the stout rays of the dorsal fin bears a small and slender pointed prominence directed backwards at its lower or articular end (Pl. XVI, fig. 2). The scales are smooth, and some of them exhibit very fine and delicate serrations on the hinder border.

Another imperfect fish of the same species from the West Quarry, Ridgeway, near Weymouth, now in the Dorset County Museum, shows the small upper circumorbital plates ornamented with large flattened tubercles of ganoine. A displaced fragment of bone bearing minute teeth seems to be part of the splenial.

Horizon and Locality.—Lower Purbeck Beds: near Weymouth, Dorset.

2. **Ophiopsis breviceps,** Egerton. Plate XVI, figs. 3—12.

1852. *Ophiopsis breviceps,* P. M. G. Egerton, Figs. and Descript. Brit. Organic Remains (Mem. Geol. Surv.), dec. vi, no. 6, pl. vi.
1895. ,, ,, A. S. Woodward, Catal. Foss. Fishes B. M., pt. iii, p. 170.

Type.—Nearly complete fish; Museum of Practical Geology, London.

Specific Characters.—A robust species about 12 cm. in length. Length of head with opercular apparatus about equal to maximum depth of trunk, which is twice as great as depth of caudal pedicle and contained about four and a half times in total length of fish. External head-bones coarsely tuberculated or rugose; marginal teeth long and slender. Dorsal fin occupying greater part of hinder two-thirds of back, with about 35 rays, of which the longest do not equal the depth of the trunk at their point of insertion; pelvic fins arising almost at the middle point between the pectorals and the caudal. Scales smooth and somewhat concave externally, with a strongly but finely serrated hinder border.

Description of Specimens.—The type specimen (Pl. XVI, fig. 3), though deepened a little by crushing, shows the general proportions of the fish and the origin of all the fins. The jaws of the left side, seen from within, are in their natural position; but the broken roof of the skull is displaced upwards and exposed from beneath. The calcified vertebral rings, though crushed and broken, are distinct; and the scales, somewhat scattered, are well displayed both in outer and in inner view. Though imperfect, the remains of the anal fin prove that it must have been comparatively small.

More or less fragmentary examples of this species are common in the Lower Purbeck Beds near Tisbury, Wiltshire, and the scattered remains are interesting as showing well several osteological characters of the fish. All the external bones appear to have been ornamented with large flat tubercles of ganoine, which are often variously fused into a vermiculating pattern (Pl. XVI, fig. 7), sometimes into a continuous film. As seen from below in one specimen (Pl. XVI, fig. 4, *pa.*) the parietal bones are longer than wide; and as seen also from above in another specimen (B. M. no. P. 9107 *b*), they are united in a very wavy median suture. The frontal bones (*fr.*) are slightly more than twice as long as the parietals, excavated laterally by the large orbit, and ending in front rather bluntly. The external ornament seems to be confined to their posterior half (B. M. no. P. 9436). A long and narrow squamosal (*sq.*), bearing an extended hyomandibular facette, bounds the parietal on each side. The parasphenoid is relatively large and expanded (B. M. no. P. 9107 *b*). The cheek is covered both by postorbital and by circumorbital plates. The upper postorbital is relatively large, deeper than wide, widest below. The large lower postorbital exhibits a few short branches radiating backwards from the curved slime-canal (Mus. Pract. Geol. no. 28441). The circumorbital ring is narrow, including three or four plates above the orbit (*co.*) and one behind. These plates are marked with the usual coarse ornament (B. M. no. P. 9436). The hyomandibular is a deep and narrow lamina of bone, with a large process for the support of the operculum. The maxilla seems to have been long and slender, but its precise shape is unknown. The premaxilla (Pl. XVI, fig. 5) forms a large irregular expansion, pierced near its upper border by a small foramen, and produced upwards into a short and slender ascending process. The oral margin bears a row of styliform teeth smaller than those of the dentary. The lower jaw (Pl. XVI, fig. 6) is much elevated in the short coronoid region, but the tooth-bearing part of the dentary is long and slender. Its outer face is marked by a row of large openings of the slime-canal, and its slender styliform teeth are arranged in a close series. There seems to have been a splenial with minute teeth (B. M. no. P. 3608). The occiput is overlapped behind by a single pair of supra-temporals as in *Amia* (Pl. XVI, fig. 4, *st.*). The operculum is not much deeper than wide, and its inner face bears a large facette for its suspension; the coarse ornament on its outer face (Pl. XVI, fig. 7) tends to radiate from this point. The

suboperculum is nearly three times as wide as deep, with an ascending process in front. The uppermost branchiostegal ray is relatively large, and the others are also stout. There seems to have been a large gular plate, but its presence is not quite certain.

In the axial skeleton of the trunk complete vertebral rings, about as long as deep, occur throughout; in the abdominal region the ribs are short and slender (B. M. no. P. 9107 *c*).

Behind the supratemporal bones, a pair of relatively large post-temporals is seen (Pl. XVI, fig. 4, *ptt.*). The supraclavicle is also large (Pl. XVI, fig. 8), about three times as deep as wide, with its exposed surface ornamented by ganoine partly disposed in irregular oblique ridges. The clavicle is wide and much arched, and similarly ornamented on its small exposed portion (B. M. no. P. 9436). The large upper postclavicular scale is shown in the type specimen (Pl. XVI, fig. 3). Fulcra have been seen on the pelvic fins (B. M. no. P. 9107 *c*), and there seem to be traces of them on the pectorals in the type specimen.

All the scales are smooth, and those of the abdominal region, besides many of the caudal region, are conspicuously though finely serrated. The principal scales of the abdominal flank are about as broad as deep, with gently curved upper and lower margins, and often marked with a few faint zig-zag lines parallel with the posterior serrations (Pl. XVI, fig. 9). They are united by a large peg-and-socket articulation (fig. 10), which becomes feeble or absent on the dorsal and ventral scales and in the hinder half of the caudal region. The dorsal scales are much broader than deep, with a tendency to the rounding of the postero-superior angle (fig. 12). The ventral scales are also broader than deep (fig. 11), those in the anterior half of the abdominal region excessively so. Ovate ridge-scales occur on the caudal pedicle, but they are scarcely enlarged.

Horizon and Locality.—Lower Purbeck Beds: Vale of Wardour, Wiltshire.

3. **Ophiopsis dorsalis,** Agassiz. Plate XVI, fig. 13.

1844. *Ophiopsis dorsalis,* L. Agassiz, Poiss. Foss., vol. ii, pt. i, p. 291, pl. xxxvi, fig. 5.
1895. „ „ A. S. Woodward, Catal. Foss. Fishes B. M., pt. iii, p. 171.

Type.—Nearly complete fish; British Museum.

Specific Characters.—A much elongated species about 16 cm. in length. Head with opercular apparatus occupying one-fifth of the total length of the fish; maximum depth of trunk twice as great as depth of caudal pedicle, and contained somewhat more than six times in the total length. External head-bones coarsely tuberculated or rugose. Dorsal fin occupying greater part of back, with about 35 rays, of which the longest do not equal the depth of the trunk at their point of insertion; pelvic fins in advance of the middle point between the pectorals and

caudal. Principal scales smooth and somewhat concave externally, with a finely serrated hinder border; some scales irregularly punctated or rugose.

Description of Specimens.—The type specimen, which is very imperfectly shown in the original figure published by Agassiz, is re-drawn of the natural size in Pl. XVI, fig. 13. The outline of the head is indicated, and there are traces of the coarse ornamentation, but the details of its osteology are obscure. The shape of the trunk is also clearly shown, and the fins are not very imperfect. There are no indications of fulcra on the pectoral fins, but they are distinct on the pelvic fins; both basal and fringing fulcra are also seen on the dorsal fin, and they are conspicuous on the upper lobe of the caudal fin. The anal fin is comparatively small and deep, with eight or nine rays. The comparatively stout caudal fin-rays are well enamelled. The scales are exposed chiefly from the inner face, and exhibit the variations in shape already described in *O. breviceps* (p. 75). Some of the scales in the abdominal region exhibit their fine serration, while a few on the caudal pedicle are covered with faintly rugose enamel. The lateral line in the abdominal region traverses the ninth or tenth row above the ventral border.

The type specimen is described by Agassiz as from the Inferior Oolite of Northampton, but the matrix appears to be Purbeck Stone, and a second example of the same species in the British Museum was certainly obtained from the Purbeck Beds of Swanage. In this specimen a few of the scales below the middle of the dorsal fin, and just in front of the pelvic fins, exhibit the faint rugosity of the enamel already noted on the caudal pedicle of the type. There is another example from Swanage in the Museum of Practical Geology, London.

Horizon and Locality.—Middle Purbeck Beds: Swanage, Dorset.

Genus **HISTIONOTUS**, Egerton.

Histionotus, P. M. G. Egerton, Ann. Mag. Nat. Hist. [2], vol. xiii, 1854, p. 434.

Generic Characters.—Head large, snout acute; dorsal margin of trunk rising above the head to an angulation from which the body gradually tapers backwards. Styliform marginal teeth very slender and closely arranged. Slime-canals on head and preoperculum comparatively large. Notochord surrounded by ring-vertebræ; ribs ossified. Fins consisting of distally bifurcating rays, all with Λ-shaped fulcra; pectoral fins much larger than the pelvic pair; dorsal fin arising at the angulation of the back, extending to the caudal pedicle, high in front, low behind; anal fin small; caudal fin forked. Scales covering the whole of the trunk, in regular series, united by peg-and-socket articulation, and more or less pectinated at the hinder border; scales of middle of flank and some of dorsal region deeper than broad, the flank-scales with more or less convex hinder border; ventral scales at least as broad as deep; postclavicular scales very large; caudal ridge-scales not much enlarged.

Type Species.—Histionotus angularis, from the English Purbeck Beds.

Remarks.—Histionotus is noteworthy for the great development of the slime-canals on the head and preoperculum. It is known only by the type species and by two or three others from the Lithographic Stone (Lower Kimmeridgian) of Bavaria and France.

1. **Histionotus angularis,** Egerton. Plate XVII, figs. 1—5.

1854–55. *Histionotus angularis*, P. M. G. Egerton, Ann. Mag. Nat. Hist. [2], vol. xiii, p. 434, and Figs. and Descript. Brit. Organic Remains (Mem. Geol. Surv.), dec. viii, no. 5, pl. v.
1889. *Histionotus angularis*, J. C. Mansel-Pleydell, Geol. Mag. [3], vol. vi, p. 241, pl. vii.
1895. *Histionotus angularis*, A. S. Woodward, Catal. Foss. Fishes B.M., pt. iii, p. 174.

Type.—Fish, wanting tail; British Museum.

Specific Characters.—Attaining a length of about 20 cm. Length of head with opercular apparatus slightly exceeding its maximum depth, and occupying about one-quarter of the total length of the fish; length of trunk equalling twice its maximum depth, and the dorsal angulation measuring approximately 148°. Head and opercular bones and large postclavicular plates externally ornamented with fine, closely arranged rugæ of enamel. Fin-rays stout and smooth; pectoral fins scarcely twice as large as the pelvic pair, and the latter arising in advance of the middle point of the trunk; dorsal fin consisting of at least 25 rays. Pectinations of the scales delicate and confined to their hinder margin, but conspicuous in all regions of the trunk.

Description of Specimens.—The type specimen is so imperfectly shown, with the caudal region so erroneously restored, in Egerton's original figure that it is re-drawn in Pl. XVII, fig. 1. The head-bones are much crushed and broken, but several can be recognised; the ventral region of the trunk is slightly deepened by crushing; and the caudal region is only vaguely indicated in impression, with a few displaced remains of the fulcra of the anal fin. The characters of the species are better seen in a fine though distorted specimen (Pl. XVII, fig. 2) described by Mansel-Pleydell (*loc. cit.*, 1889), and various features are shown by several more imperfect specimens in the British Museum and the Dorset County Museum.

The deep laterally compressed skull is remarkable for the great development of the slender ethmoidal region, which is as long as the frontals. The parietals (Pl. XVII, fig. 3, *pa.*) are conspicuous behind, each slightly longer than broad, and covered with the rugose enamelled ornament, which tends to an antero-posterior direction in the anterior half but is disturbed by a large transverse slime-canal in the posterior half. The squamosals have not been clearly observed. The frontals (fig. 3, *fr.*) are about twice as long as the parietals, slightly arched over the large orbit and not much tapering in front. In their postorbital expansion the rugose ornament is sparse, but in their interorbital portion it is more conspicuous and

tends towards longitudinal ridges. The frontals are also traversed by a pair of very large slime-canals. No superficial plates have been observed on the long ethmoidal region. The stout parasphenoid is usually distinct crossing the orbit. The cheek seems to have been covered with plates, but only those in the upper part of the circumorbital ring have hitherto been clearly observed (fig. 3, *co.*). They are narrow, four in number, the foremost the longest and tapering in front, all finely ornamented with irregular tubercles of ganoine.

The mandibular suspensorium is much inclined forwards, so that the quadrate articulation is beneath the front border of the orbit and the mouth is very small. One of the bones of the pterygo-palatine arcade, either palatine or ectopterygoid (Pl. XVII, fig. 4), bears a close series of comparatively large and stout conical teeth. The marginal teeth of both jaws, also in close series, are slender and styliform. The maxilla, crushed and broken in the type specimen (Pl. XVII, fig. 1, *mx.*), is a rather large smooth lamina of bone, deepest behind, and not showing any teeth. A fragment in another specimen (B.M. no. P. 3614), however, seems to bear a very small styliform tooth. The dentary (*d.*) is comparatively slender, and marked by large perforations for the slime-canal.

The opercular apparatus is complete. The preoperculum (Pl. XVII, figs. 1, 2, *pop.*), which is widely expanded at the angle and has a relatively small lower limb, is smooth except at the upper end, where it bears a few oblique ridges. It is deeply excavated with a few large pits for the well-developed slime-canal. The operculum (*op.*), which is about two-thirds as wide as deep, is closely ornamented, except at its upper end, with coarse tubercles of ganoine which tend to fuse into short ridges radiating from the point of suspension. The suboperculum (*sop.*), which is about one-quarter as deep as the operculum, is similarly ornamented, and bears a large smooth ascending process in front. The triangular interoperculum (*iop.*), which is about as deep as broad, and the large upper branchiostegal rays (*br.*) are also ornamented in their lower portion by tubercles of ganoine which are more or less fused into short oblique ridges. The extent of the branchiostegal apparatus between the mandibular rami is unknown.

The vertebral axis is usually obscured by the dense squamation, but broad well-ossified vertebral rings have been seen in one fragmentary specimen (B.M. no. P. 3614).

The occipital border of the cranium is overlapped by supratemporals (fig. 1, *st.*), of which it can only be stated that they bear a row of relatively large pits for the transverse slime-canal. A large triangular post-temporal (fig. 1, *ptt.*) on each side, as usual, supports the pectoral arch; it is ornamented with tubercles and short ridges of ganoine only at its hinder border. The supraclavicle (fig. 1, *scl.*) is ornamented only at its upper end and above the passage of the slime-canal, and tapers to a blunt point below. The clavicle (fig. 1, *cl.*) is relatively large and smooth, sometimes with traces of tubercles of ganoine on its posterior angle. There

are the usual three large postclavicular plates (fig. 2, *pcl.*) ornamented like the opercular bones. The pectoral fin in the type specimen measures 2·5 cm. in length and comprises nine or ten rays, of which the foremost is the stoutest and fringed with small fulcra; the basal half of each ray is undivided, but the distal half is closely articulated and more or less subdivided. The pelvic fin is smaller, with very large uniserial fulcra. The dorsal fin (Pl. XVII, fig. 2) comprises about twenty-five well spaced stout rays, which are closely articulated and subdivided for the greater part of their length. Its foremost rays are ornamented with smooth longitudinal ridges of ganoine, and its anterior border is fringed with large uniserial fulcra, of which a few are basal and gradually increase in length. The anal fin is very small, with about four rays. The caudal fin is clearly forked, with about eight enamelled rays in each lobe, and the fulcra on the upper lobe larger than those on the lower lobe.

All the scales, except a few between the base of the pectoral fins, are completely covered with smooth enamel, and most of them even in the caudal region are finely pectinated at the hinder border. The total number of transverse series, counted along the course of the lateral line, is about 40; and the number of scales in a transverse series above the pelvic fins is about 12. The principal scales of the flank in the abdominal region, which have often a slightly convex pectinated edge, are from two to three times as deep as broad, while those of the flank in the caudal region are also deeper than broad. Nearly all the scales dorsally and ventrally are at least as deep as broad, and very few are destitute of posterior serration or pectination, though their shape is often more or less irregular. The scales immediately bordering the dorsal fin are especially peculiar in shape, truncated and usually widest at their upper end, concave at their posterior pectinated edge; four small smooth-edged scales of irregular shape are separated from them beneath the fulcra and foremost ray of this fin. Three or four smooth-edged diamond-shaped ridge-scales, not much enlarged, occur on the caudal pedicle between the dorsal and caudal fins. As shown in the type specimen, a few smooth-edged scales also occur on the narrow ventral face of the abdominal region; while some of the smaller scales between and in front of the base of the pectoral fins bear only isolated ridges and tubercles of enamel. The lateral line traverses the seventh row of scales above the ventral border in the abdominal region. Externally it is only feebly marked by a ridge and notch on each scale, with an occasional perforation, but on the inner face it forms a deep groove (Pl. XVII, fig. 5, *l.*). The smaller perforations of an upper slime-canal are also seen on the scales at the base of the dorsal fin. Nearly all the scales are strengthened by a broad median vertical ridge on the inner face, and most are united by a broad peg-and-socket articulation (Pl. XVII, fig. 5).

Horizon and Localities.—Middle Purbeck Beds: Swanage, Dorset; Tisbury, Wiltshire.

Genus **ENCHELYOLEPIS**, novum.

Generic Characters.—Head large, snout acute; trunk gradually tapering from the occiput backwards. Marginal teeth much elongated, closely arranged. Notochord invested with delicate ring-vertebræ; neural and hæmal arches especially short and stout. Fins consisting of robust, bifurcating rays, without fulcra except in the caudal; pectoral fins larger than the pelvic pair; dorsal fin with very stout supports, arising immediately behind the occiput and extending continuously to the caudal pedicle; anal fin small; caudal fin not forked. Scales very thin and deeply overlapping, the exposed portion rounded and exhibiting a regularly reticulated structure; no enlarged ridge-scales on caudal pedicle.

Type Species.—*Enchelyolepis andrewsi*, from the English Purbeck Beds.

Remarks.—This genus is known only by two small specimens representing two species, the one from the Purbeck Beds described below, the second from the Upper Portlandian of Savonnières-en-Perthois, Meuse, France. The latter was described under the name of *Macrosemius pectoralis* by H. E. Sauvage (Bull. Soc. Géol. France [3] vol. xi, 1883, p. 477, pl. xii, fig. 17), and is re-figured for comparison with the Purbeckian species in Pl. XVII, fig. 7. The genus is distinguished from *Macrosemius* and all other Macrosemiidæ by its peculiar thin squamation; it also differs from all genera of this family, except *Petalopteryx*, in the stoutness of its neural and hæmal arches and of the dorsal and anal fin-supports.

The scales of *Enchelyolepis* are perhaps most closely similar to those of *Amia*, but the reticulate structure of their exposed portion is rather suggestive of that of the scales of eels.

1. **Enchelyolepis andrewsi,** A. S. Woodward. Plate XVII, fig. 6.

1895. *Macrosemius andrewsi*, A. S. Woodward, Geol. Mag. [4] vol. ii, p. 148, pl. vii, fig. 3; and Catal. Foss. Fishes B. M., pt. iii, p. 180.

Type.—Nearly complete fish; British Museum.

Specific Characters.—A very small species about 35 mm. in length. Length of head with opercular apparatus considerably exceeding its maximum depth, and contained about three and a half times in the total length to the base of the caudal fin; maximum depth of trunk twice that of caudal pedicle. Pelvic fins inserted about midway between the pectoral and caudal fins; dorsal fin much less deep than the trunk, with about 25 slender rays; anal fin with 7 or 8 rays. All scales apparently broader than deep.

Description of Specimen.—The type specimen, discovered by the Rev. W. R. Andrews, is shown somewhat enlarged in Pl. XVII, fig. 6, and is preserved in counterpart. The remains of the head are merely sufficient to show that it is shaped as in the Macrosemiidæ, with a comparatively small terminal mouth and a close series of styliform teeth in both jaws. There are apparently pro-otic and opisthotic ossifications in the lateral wall of the brain-case. An epihyal and a relatively large ceratohyal bear a few branchiostegal rays, of which four are slender and much curved. In the vertebral axis there are about 35 segments, of which 14 may be reckoned as abdominal. Centra seem to be represented by delicate complete cylinders in the abdominal region, but by not more than small pleurocentra and hypocentra in the caudal region—a condition possibly due to the immaturity of the specimen. In *Enchelyolepis pectoralis*, however, complete vertebral rings are seen throughout the axis (Pl. XVII, fig. 7). The ribs are comparatively slender, and are far from reaching the ventral border of the fish. The neural arches generally, and the hæmal arches in the caudal region, are very short and stout and much inclined to overlap. A few of the anterior neural arches are expanded at the upper end, which is seen to be forked in *E. pectoralis;* about four of the neural arches at the base of the caudal fin are longer than the others and very closely arranged. Eight or nine elongated hæmals are supports of the caudal fin. The stout clavicle is considerably expanded above the pectoral fin, which is inserted close to the ventral border of the fish, but is only fragmentary in the fossil. In *E. pectoralis* the pectoral fin consists of about 12 articulated rays supported by 4 well-calcified basals which rapidly decrease in size from below upwards. Each pelvic fin-support is characterised by its relatively large and wide proximal triangular expansion; while between this support and the 5 or 6 pelvic fin-rays in *E. pectoralis* there seem to be small nodular baseosts. The dorsal fin seems to have been equally elevated throughout its length, and some of the rays clearly show their distal bifurcation. All its 25 supports (fig. 6 *a*) are especially stout, larger than the neural spines, and sharply curved forwards at their pointed lower end. Between each of these supports and its corresponding ray is intercalated a very short bony rod, as in *Amia*[1]—an arrangement seen again in *Enchelyolepis pectoralis*, where there is also another small nodule of bone between the short rod and the fin-ray (fig. 7 *a*). The anal fin, with its 7 rays, exhibits similar stout supports. Of the caudal fin only the base is preserved; but in *E. pectoralis* it is nearly complete and shows the rounded or truncated posterior border. Traces of scales are vaguely seen over nearly the whole of the trunk in the fossil, but they must have been extremely thin. They appear to be at least as long as deep and much overlapping, the large covered portion being marked only by the usual concentric lines of growth, while the small exposed portion, which is rounded at the hinder border, has a regular reticulate structure (Pl. XVII, fig. 6 *b*).

[1] T. W. Bridge, in 'The Cambridge Natural History,' vol. vii (1904), p. 235, fig. 136.

Traces of similar scales also occur in *E. pectoralis*, some fragments overlying the pelvic bones being especially clear (Pl. XVII, fig. 7 *b*). The only fulcral scales are at the base of the upper lobe of the tail.

Horizon and Locality.—Middle Purbeck Beds: Vale of Wardour, Wiltshire.

Family Eugnathidæ.

Genus **CATURUS**, Agassiz.

Caturus, L. Agassiz, Neues Jahrb. f. Min., etc., 1834, p. 387.
Uræus, L. Agassiz, Poiss. Foss., vol. ii, pt. i, 1833, p. 12, (*non Uræus*, Wagler, 1830).
Conodus. L. Agassiz, *tom. cit.*, pt. ii, 1844, p. 105 (name only).
Strobilodus, A. Wagner, Abhandl. k. bay. Akad. Wiss., math.-phys. Cl., vol. vi, 1851, p. 75.

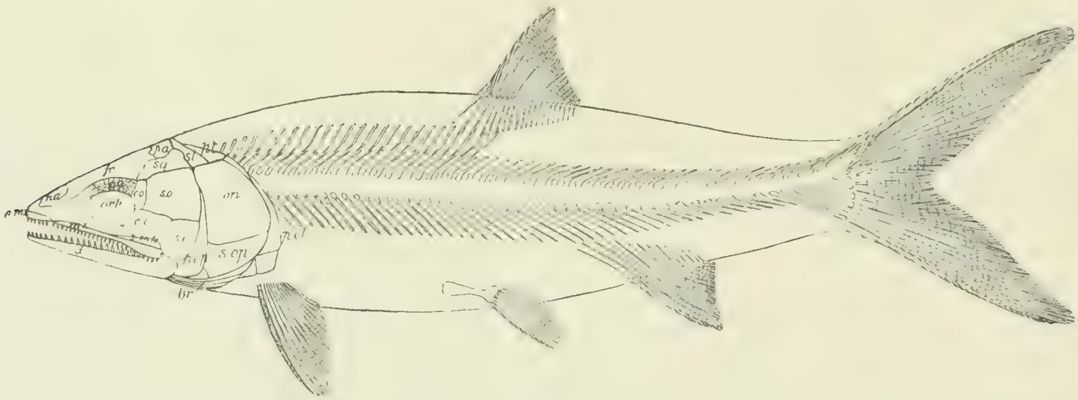


Fig. 26.—*Caturus furcatus*, Agassiz; restoration, scales omitted, much reduced in size.—Lower Kimmeridgian (Lithographic Stone); Bavaria. *br.*, branchiostegal rays; *co.*, circumorbitals; *d.*, dentary; *fr.*, frontal; *mx.*, maxilla; *na.*, nasal; *op.*, operculum; *orb.*, orbit; *pa.*, parietal; *pcl.*, postclavicular plates; *pmx.*, premaxilla; *pop.*, preoperculum; *pt.*, post-temporal; *smx.*, supramaxilla; *so.*, postorbitals; *sop.*, suboperculum; *sq.*, squamosal; *st.*, supratemporal.

Endactis, P. M. G. Egerton, Figs. and Descripts. Brit. Organic Remains (Mem. Geol. Surv.), dec. ix, 1858, no. 4.
Thlattodus, R. Owen, Geol. Mag., vol. iii, 1866, p. 55.
Ditaxiodus, R. Owen, *tom. cit.*, 1866, p. 107.

Generic Characters.—Trunk elongate-fusiform. External head-bones and opercular bones feebly ornamented with rugæ and tuberculations, all except the cheek-plates robust; upper circumorbitals subdivided into small tesseræ; snout obtusely pointed, and maxilla straight or with a somewhat concavely arched dentigerous border; teeth relatively large and tipped with enamel, arranged in a sparse series on the margin of the jaws, smaller on the palatine and on the splenial, where they are in single series anteriorly, minute and almost granular on the other inner bones; preoperculum narrow, nearly smooth; operculum deep, much broader below than above, and suboperculum of moderate size. Ossifications round the notochord insignificant or absent in the smaller species, consisting only of separate hypocentra and pleurocentra in the largest species; ossified ribs

slender, not reaching the ventral border of the abdominal region. Fulcra biserial, well-developed on all the fins, those of the pectoral being especially elongated and sometimes in part fused together. Pectoral much exceeding the pelvic fins in size, but the latter well-developed; dorsal and anal fins triangular in shape, the former arising opposite or immediately behind the pelvic fins; caudal fin deeply forked. Scales thin, smooth, feebly crimped or in part tuberculated, deeply overlapping, and none much deeper than broad; a few anterior series quadrangular and sometimes united with peg-and-socket, the others more or less cycloidal, and very few narrowed near the ventral border. Lateral line inconspicuous.

Type Species.—*Caturus furcatus* (L. Agassiz, Poiss. Foss., vol. ii, pt. ii, 1842—44, p. 116, pl. lvi *a*) from the Lithographic Stone (Lower Kimmeridgian) of Bavaria. See Text-fig. 26.

Remarks.—This genus is represented only by fragments in the Wealden and Purbeck Formations. It is known by many nearly complete fishes from the

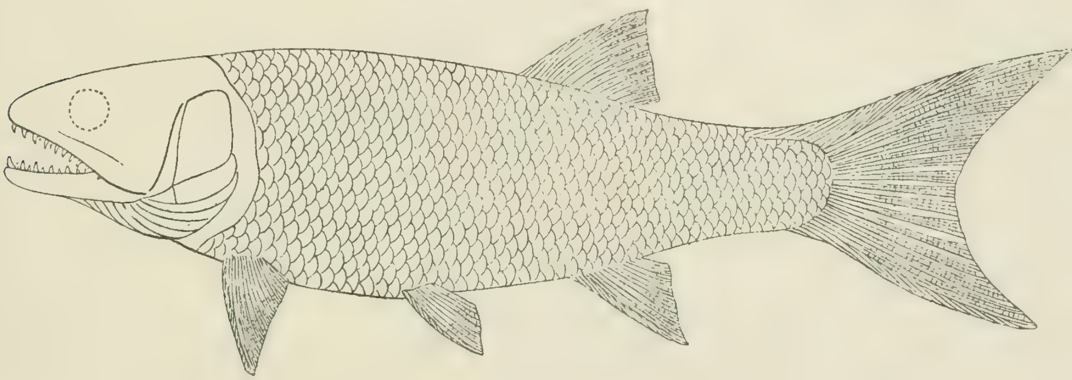


FIG. 27.—*Callopterus insignis*, Traquair; restoration, showing scales, much reduced in size.—Wealden; Bernissart, Belgium. After R. H. Traquair.

Lithographic Stone of Germany and France; and its cranial osteology is well displayed in numerous fragmentary specimens discovered by Mr. Alfred N. Leeds in the Oxford Clay near Peterborough (A. S. Woodward, Ann. Mag. Nat. Hist. [6] vol. xix, 1897, pp. 292—297, pls. viii, ix).

1. **Caturus (Callopterus?) latidens,** sp. nov. Text-figure. 28.

Type.—Imperfect skull; British Museum.

Specific Characters.—Marginal teeth broad, laterally compressed near the apex, and bluntly pointed; those of middle of maxilla about as deep as the bone at their insertion.

Description of Specimen.—The type and only known specimen was discovered by Mr. S. H. Beckles in a waterworn fragment of Wealden ironstone on the beach near Hastings. It exhibits only remains of the head, which are very fragmentary (Text-fig. 28).

The skull must have measured originally about 10 cm. in length, but the parietal and occipital regions are missing. The remains of the thick rugose frontal bones (*fr.*) show the usual deep interdigitation of their median suture in the region between the postfrontals (sphenotics). The tapering anterior end of the narrow squamosal is also seen bordering the hinder end of the frontal on the left side (*sq.*). The cheek-plates are marked with a finer rugosity than that of the cranial roof, with some tuberculation. Both the postorbitals (*so.*) are imperfect, but the lower seems to be the larger, its subdivision not being clear. The postero-

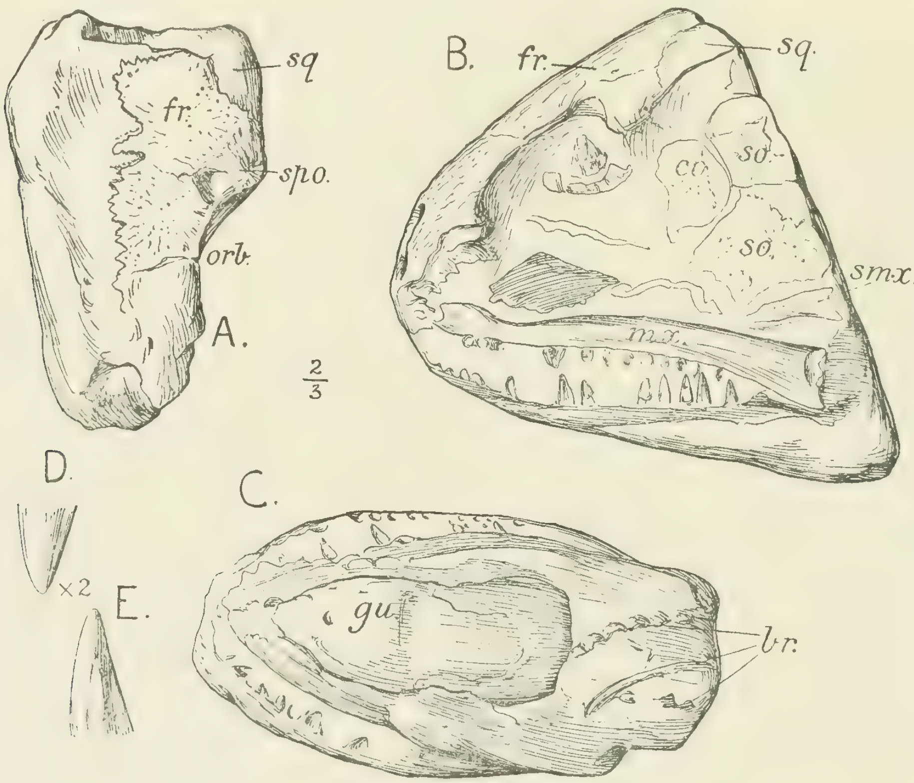


FIG. 28.—*Caturus latidens*, sp. nov.; imperfect head, upper (A), left side (B), and lower (C) views, two-thirds nat. size, with upper (D) and lower (E) teeth enlarged twice.—Wealden; Hastings, Sussex. Beckles Collection (B. M. no. P. 6360). *br.*, branchiostegal rays; *co.*, posterior circumorbital; *fr.*, frontal; *gu.*, gular; *mx.*, maxilla; *orb.*, orbit; *smx.*, supramaxilla; *so.*, postorbitals; *spo.*, sphenotic (postfrontal); *sq.*, squamosal.

superior circumorbital (*co.*), as usual, is deeper than wide, and there seem to be remains of the irregular superior circumorbitals. One of the antorbitals, a little displaced, is an elongated irregularly rhomboidal plate. The maxilla (*mx.*) exhibits the ordinary constriction near its anterior end, and is not much deepened behind; its outer face is comparatively smooth, marked only by a few irregular longitudinal grooves. Its hinder end was originally bordered by a single narrow supramaxilla, similarly ornamented, which tapers to a point in front (*smx.*). Most of the maxillary teeth are broken away, exposing their very large pulp-cavity.

They are nearly round in section at their base, but, as shown in the right maxilla, their blunt apex is laterally compressed (Text-fig. 28, D). A cluster of nearly similar teeth, curved and apparently less compressed at the apex, occurs in front of the right maxilla on a thick piece of bone which may represent the palatine. The mandible is very fragmentary, but its lower border must have been much curved inwards, and its coronoid region rises abruptly into the usual considerable elevation. Its teeth (E) resemble those of the maxilla (D), but seem to be somewhat larger. The gular plate (*gu.*), which occurs in position between the mandibular rami, is especially large, reaching as far backwards as the hinder end of the tooth-bearing border of the dentary. Traces of the anterior branchiostegal rays (*br.*) show that they are thick rather than laminar.

Remarks.—As suggested by the shape of the teeth, it is possible that this species may not belong to *Caturus*, but to the closely allied genus *Callopterus* (with a more remote dorsal fin), which has already been recorded from the Wealden of Belgium by R. H. Traquair, 'Les Poissons Wealdiens de Bernissart' (Mem. Mus. Roy. Hist. Nat. Belg., vol. v, 1911, p. 34, pl. vi). See Text-fig. 27, p. 83.

Horizon and Locality.—Wealden: Hastings, Sussex.

2. **Caturus purbeckensis,** A. S. Woodward. Plate XIX, figs. 1, 2.

1890. *Strobilodus purbeckensis*, A. S. Woodward, Proc. Zool. Soc., p. 350, pl. xxix, fig. 4.
1895. *Caturus* (*Strobilodus*) *purbeckensis*, A. S. Woodward, Catal. Foss. Fishes Brit. Mus., pt. iii, p. 348.

Type.—Head; British Museum.

Specific Characters.—Head with opercular apparatus usually attaining a length of from 10 to 15 cm.; external bones without ornament. Maxilla a little curved downwards behind, where its teeth become comparatively small and slender; teeth of middle of maxilla much deeper than the bone at their insertion. Mandible very slender, pointed, and tending to curve upwards in front; height of middle dentary teeth nearly equal to depth of the bone at their insertion. All the teeth tumid, often with an external indent, at their base, becoming very slender in their incurved apical half, and tipped by a laterally compressed cap of translucent ganodentine with prominent edges.

Description of Specimens.—This species is known only by the imperfect specimen of the head and adjoining parts shown in Pl. XIX, fig. 1, and by detached jaws.

The cranium is so much crushed in the type specimen (Pl. XIX, fig. 1) that its characters can only be vaguely seen. The roof-bones are marked by a faint rugosity and numerous irregular fine pittings. The postfrontal (sphenotic) is well ossified; and the stout parasphenoid, where it crosses the orbit and eventually underlaps the vomers, is a depressed lamina. The postorbital cheek-plates and the large hinder circumorbitals are smooth, exhibiting only very fine scattered pittings

or punctations. The upper circumorbitals, as usual in *Caturus*, seem to have been irregularly subdivided. The mandibular suspensorium is inclined backwards, and the stout hyomandibular is visible beneath the cheek-plates. The maxilla (*mx.*) is smooth, with slight longitudinal grooving, and its hinder end is overlapped by a long and narrow supramaxilla (*smx.*). It exhibits its usual slight sinuosity, and is a little deepened where its oral border curves downwards behind. The relatively large teeth with their nearly square base fused to the bone, their extensive inner cavity, and their slender incurved apical half, with a triangular tip of ganodentine, are well seen: they become especially small and slender behind. The extended premaxilla (*pmx.*), with five or six tooth-sockets, seems to have borne rather larger teeth. The mandible, shown both in the type specimen and in a smaller specimen (Pl. XIX, fig. 2), displays its characteristic upturned pointed symphysial end, and rises behind into a short coronoid region, in which the ordinary separate coronoid bone (*co.*) and small angular bone (*ag.*) can be distinguished. The dentary (*d.*) is a nearly smooth bone, punctate in part and marked by a row of pits along the course of the slime-canal; the angular bone is strongly punctate. The teeth resemble those of the maxilla, but are somewhat larger. The teeth of both jaws often exhibit a median indent on their outer face at the base; and the bone round their insertion is sometimes marked with very fine short radiating grooves or crimpings.

A dentary bone in the Sedgwick Museum, Cambridge, is one-third larger than that of the type specimen; and part of another dentary in the Beckles Collection (B.M. no. P. 6388) is equally large.

The remains of the opercular bones in the type specimen are smooth, apart from fine punctations; and the clavicle (*cl.*) is only marked by a few vertical lines within its overlapped margin. Ossified hypocentra (*hy.*) are seen in the anterior part of the trunk, besides neural arches and ribs, partly obscured by the usual thin scales. The base of the pectoral fin (*pct.*) shows the stoutness of its smooth, closely adpressed rays.

Horizon and Locality.—Middle Purbeck Beds: Swanage, Dorset.

3. **Caturus tenuidens,** A. S. Woodward. Plate XIX, figs. 3, 4.

1895. *Caturus tenuidens*, A. S. Woodward, Geol. Mag. [4], vol. ii, p. 151, pl. vii, figs. 7, 8.

Type.—Mandibular ramus; British Museum.

Specific Characters.—Teeth very slender, usually incurved at the apex, less swollen at the base than in the type species and in *C. purbeckensis*, usually well-spaced in the jaw. Dentary bone almost smooth, curved a little upwards at its pointed symphysial end; height of teeth in middle of dentary series much less than the depth of the bone at their insertion.

Description of Specimens.—This species is still known only by isolated dentary bones and maxillæ, which are not uncommon in the Middle Purbeck Beds of Swanage. As they are smaller than some of the corresponding bones of *C. purbeckensis*, they might at first be regarded as representing the young of the latter species; but if dentaries of nearly the same size be compared (as in Pl. XIX, figs. 2, 4), the more slender proportions of *C. tenuidens* are evident. All the teeth, when well preserved, exhibit the usual little triangular apex of translucent ganodentine. The characteristic maxilla shown in inner view in Pl. XIX, fig. 3, is nearly complete, displaying the shape of the hinder slight expansion and the depressed anterior half of the bone.

Horizon and Locality.—Middle Purbeck Beds: Swanage, Dorset.

Genus **NEORHOMBOLEPIS**, A. S. Woodward.

Neorhombolepis, A. S. Woodward, Proc. Geol. Assoc., vol. x, 1888, p. 304.

Generic Characters.—Trunk elongate-fusiform, more or less laterally compressed, and head relatively large. External head-bones and the opercular bones stout, more or less ornamented with tubercles and rugæ of ganoine, but no prominent bosses or outgrowths. Maxilla with a straight tooth-bearing border and a long supramaxilla; teeth conical, in regular series, large and hollow on the margin of the jaw, not in sockets; a patch of minute teeth on the parasphenoid. Suboperculum at least half as large as the operculum, which is quadrangular but truncated at the postero-superior angle. Vertebral centra either ring-shaped or completely ossified. Fulcra well-developed on the pectoral fins, probably on the other fins. Scales rhombic and thick, with a wide overlapped margin not produced at the angles, and the peg-and-socket articulation feeble or wanting; superficial ganoine nearly smooth; few principal flank-scales as deep as broad, the majority broader than deep, and those of numerous ventral series at least twice as broad as deep, sometimes subdivided.

Type Species.—*Neorhombolepis excelsus* (A. S. Woodward, Proc. Geol. Assoc., vol. x, 1888, p. 304, pl. i, fig. 1; also Foss. Fishes of English Chalk—Pal. Soc., 1909—p. 158, pl. xxxiv, fig. 1) from the English Lower Chalk.

Remarks.—A detailed study of the type specimen of the Wealden species described below, modifies the original definition of *Neorhombolepis* by making known the fulcra on the pectoral fins.

1. **Neorhombolepis valdensis**, A. S. Woodward. Plate XVIII.

1895. *Neorhombolepis valdensis*, A. S. Woodward, Catal. Foss. Fishes B.M., pt. iii, p. 356, pl. viii, fig. 5.

Type Specimen.—Imperfect fish; British Museum.

Specific Characters.—As large as the type species, skull attaining a length of about 8 cm. External head-bones ornamented with large flattened tubercles of ganoine. Scales smooth but often marked with a few fine punctations; hinder border of all the principal abdominal scales delicately serrated.

Description of Specimen.—The type and only known specimen was discovered by Mr. S. H. Beckles in a waterworn fragment of Wealden ironstone on the beach near Hastings. The fish is curled up, dislocated across the end of the abdominal region, and partly exposed on both sides of the pebble. The remains are shown of the natural size in Pl. XVIII, figs. 1—4.

The roof of the skull must have been nearly flat, with the postorbital region about two-thirds as long as broad, and the interorbital region much excavated by the relatively large orbits. Of the roof-bones only portions of the parietals (*pa.*) and squamosals (*sq.*) are well seen, these evidently uniting with the frontals in a deeply interdigitating suture. They have a somewhat wrinkled surface, irregularly ornamented with large flattened tubercles of ganoine. The parasphenoid (fig. 2, *pas.*), seen on the left side of the fossil, extends as far back as the occiput. Its hinder portion is laterally compressed to a sharp median ridge below; between its lateral wings the lower face widens to bear a small elongate-oval patch of minute teeth; and further forwards it evidently becomes more expanded. Its lateral wing is relatively large and bifurcated, the anterior limb rising as usual to meet the post-frontal or sphenotic (*ptf.*), while the posterior limb reaches one of the hinder otic elements. Remains of cheek-plates occur on the right side, ornamented like the bones of the cranial roof with large, irregular, flattened tubercles of ganoine. The postorbitals (*po.*) must have been relatively large; and there are small circum-orbitals (*co.*) above the eye.

The right hyomandibular (*hm.*) occurs in its natural position and shows that the mandibular suspensorium is nearly vertical. This bone is laterally compressed and more expanded above than below, bearing a large and deep prominence for the suspension of the operculum. At least half of its lower end articulates with the symplectic (*sy.*), which is widest above, then becomes much constricted in its lower half, and thickens again a little at its lower end, which may have articulated with the mandible as in *Amia* and *Caturus*. The quadrate (*qu.*) and pterygoid bones are thin laminæ, only imperfectly shown on the right side of the fossil. Traces of a patch of small teeth are recognisable below the anterior end of the ectopterygoid. A fragment and a partial impression of the long and slender maxilla (*mx.*) show a regular series of stout, hollow, conical teeth. The hinder end of the mandible (*md.*), with part of the elevated coronoid region, is seen on the right side; and a splintered fragment of the dentary, with its regular series of stout conical teeth, occurs on the left (fig. 4).

The opercular apparatus is almost unknown; but one bone on the right side

(fig. 1, *x.*) may be the interoperculum, while traces of broad branchiostegal rays are seen on the left (fig. 2, *br.*). The supposed interoperculum, which is exposed from the inner face, is about twice as long as its greatest depth.

Traces of ossified centra, perhaps only cylinders, are seen throughout the vertebral column; and in the middle of the fish, where the column is dislocated, they are well displayed in side view (*v.*). They are smooth, mostly as long as deep, not mesially constricted, but laterally compressed above and below to a longitudinal ridge for the support of the arch. Some of the neural arches are seen to be not completely fused with the centra; and two of those in the anterior part of the caudal region exhibit the relatively small and slender neural spine (*n. a.*) bent sharply backwards from the deep pedicle.

In the pectoral arch the supraclavicle (fig. 1, *scl.*) is relatively large, three times as deep as wide, truncated and hollowed at the upper articular end, bluntly rounded below. Its exposed portion bears large flattened tubercles of ganoine, which are partly fused together. The slender clavicle, as far as seen on the left side (fig. 2, *cl.*), is not enamelled. The rather large postclavicular scales (figs. 1, 2, *pcl.*), so far as preserved, are completely covered with ganoine except at the overlapped margin, and are partly ornamented with coarse flattened rugæ and tuberculations. They are evidently arranged as in the typical *Eugnathus*, the uppermost being the largest, deep and triangular, its apex extending upwards somewhat above the lower end of the supraclavicle. As shown on the left side, the pectoral fin (fig. 3, *pct.*) comprises a few more than 20 rays, of which each is undivided in its proximal two-thirds but becomes very finely branched and articulated distally. The foremost ray is enlarged at its proximal end where it projects upwards above the others; and it is fringed with elongated, deeply overlapping fulcra, of which the two uppermost are the stoutest and must have been in direct contact with the basal supports. Both the fulcra and some of the anterior fin-rays bear traces of ganoine. On the right side of the fossil, only two fragments of the pectoral fin remain (fig. 1, *pct.*), but the characteristic elongated fulcra are seen fringing the articulated distal portion. Of the other fins merely imperfect traces of the dorsal (*d.*) and caudal (*c.*) are exposed.

The principal scales of the flank and some of the narrow ventral scales in the abdominal region exhibit a very fine sparse pitting of the enamel and a regular delicate serration or pectination of the hinder border, but the other scales are smooth. They are most deeply overlapping, with the best developed peg-and-socket articulation, on the anterior part of the flank. Very few of the flank-scales are as deep as broad, most being longer than deep, and those near the ventral margin especially elongated. Many of the ventral scales in the abdominal region are subdivided into small irregularly rhombic scales which only slightly overlap (fig. 3). Some of the scales of the lateral line are pierced by a simple short vertical slit.

Horizon and Locality.—Wealden : Hastings, Sussex.

Family AMIIDÆ.

Genus **AMIOPSIS**, Kner.

Amiopsis, R. Kner, Sitzungsb. k. Akad. Wiss. Wien, math.-naturw. Cl., vol. xlviii, pt. i, 1863, p. 126.

Generic Characters.—Trunk elongate and laterally compressed. Head large; all the marginal teeth large and conical, but those of the dentary largest; inner teeth smaller; maxilla laterally compressed and deepened behind. Vertebral centra completely ossified in the adult, biconcave, the hypocentra and pleurocentra forming distinct alternating discs in the caudal region; each centrum impressed with three or more extended pits on its side; ribs short. Fins without fringing fulcra, the rays articulated and branching; dorsal fin occupying not more than one-third of the back; anal fin small and short-based; caudal fin with convex

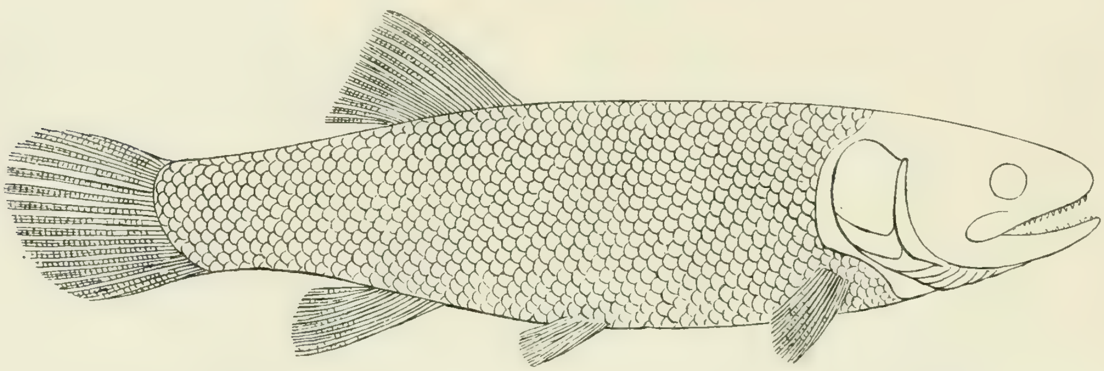


FIG. 29.—*Amiopsis dolloi*, Traquair; restoration, showing scales, much reduced in size.—Wealden; Bernissart, Belgium. After R. H. Traquair.

hinder border. Scales almost oval in shape, the long axis horizontal; exposed portion thickened.

Type Species.—*Amiopsis prisca* (R. Kner, *loc. cit.*, 1863, p, 126, pl. i), from the Cretaceous of Mrzlek, valley of the Isonzo, Istria.

Remarks.—This genus was not satisfactorily defined until 1895, when Kramberger described well-preserved specimens of the typical species (Djela Jugoslav. Akad., vol. xvi, p. 12, pl. iii, fig. 2, pl. iv). The pittings in the side of the vertebral centra distinguish it from *Megalurus* (L. Agassiz, Poiss. Foss., vol. ii, pt. i, 1833, p. 13), which occurs typically in the Lithographic Stone (Lower Kimmeridgian) of Germany, and has also been found in the Lower Cretaceous of Bahia, Brazil (*Megalurus mawsoni*, A. S. Woodward, Ann. Mag. Nat. Hist. [7] vol. ix, 1902, p. 87, pl. ii). Two species, *Amiopsis dolloi* (Text-figs. 29, 30) and *A. lata*, from the Wealden of Bernissart, Belgium, have been described by R. H. Traquair, Mém. Mus. Roy. d'Hist. Nat. Belg., vol. v, 1911, pp. 37, 42, pls. vii, viii.

1. **Amiopsis damoni** (Egerton). Plate XIX, figs. 5, 6.

1858. *Megalurus damoni*, P. M. G. Egerton, Figs. and Descript. Brit. Organic Remains (Mem. Geol. Surv.), dec. ix, no. 8, pl. viii.
(?) 1873. *Megalurus damoni*, V. Thiollière, Poiss. Foss. Bugey, pt. ii, p. 22, pl. ix.
1895. *Megalurus damoni*, A. S. Woodward, Catal. Foss. Fishes, B. M., pt. iii, p. 366.

Type Specimen.—Imperfect fish; British Museum.

Specific Characters.—Attaining a length of about 30 cm. but usually smaller. Length of head with opercular apparatus exceeding maximum depth of trunk and contained about five times in total length of fish; depth of caudal pedicle contained scarcely five times in length from operculum to base of middle caudal fin-rays. External bones slightly rugose, otherwise not ornamented. About 55 vertebræ,

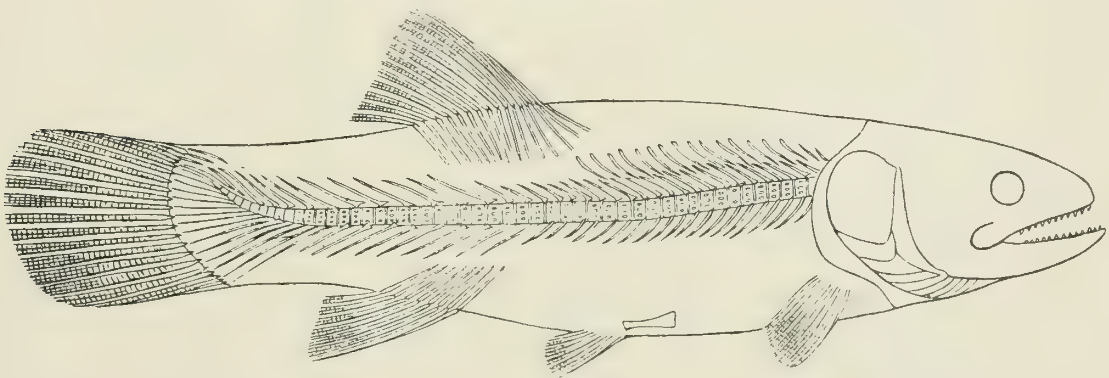


Fig. 30.—*Amiopsis dolloi*, Traquair; restoration, scales omitted, much reduced in size.—Wealden; Bernissart, Belgium. After R. H. Traquair.

half being abdominal. Dorsal fin with about 17 supports, occupying the middle of the back; anal fin with 8 supports, arising opposite the hinder end of the dorsal; pelvic fins inserted opposite the origin of the dorsal. Scales broader than deep, their hinder border not thickened.

Description of Specimens.—The type specimen exhibits most of the generic and specific characters of the fish, and another specimen, even better preserved, is shown of the natural size in Pl. XIX, fig. 5. The bones of the head, though stout, are always much crushed and broken in the fossils. The parietal, squamosal, and frontal bones are as in *Amia*, forming a cranial shield only gently arched from side to side and ornamented with a feeble coarse rugosity. A single pair of supra-temporal plates overlaps the occipital border. The outer margin of each frontal is slightly excavated above the orbit; and in one specimen (B. M. no. 41171) this excavation is occupied by four nearly smooth plates of a narrow circumorbital ring. Traces of similar plates are also seen in the type specimen. The mandibular suspensorium is gently arched forwards so that the quadrate articulation is beneath

the hinder border of the orbit. As shown by the type specimen, the maxilla is smooth and shaped as in *Amia;* so far as can be seen in several specimens, the mandible is also Amioid, the dentary bearing a single regular close series of smooth high conical teeth. The preoperculum, as shown in the type specimen, is a narrow arched bone, nearly smooth; the operculum (B. M. no. 41171) must have been nearly as broad as deep; the suboperculum is somewhat more than half as deep as the operculum, with a stout anterior ascending process; the triangular interoperculum is broader than deep; and several of the upper branchiostegal rays are wide laminæ. None of the opercular bones are marked by more than feeble coarse rugæ, which are seen to be radiating on the operculum of the type specimen.

The vertebral centra are well ossified, and all are marked by two principal lateral pits, one above, one below a longitudinal median ridge, which is impressed with a variable number of comparatively small pits. In the abdominal region the centra are about as long as deep, apparently without any processes for the support of the ribs, which are short, stout, and curved. The neural arches in advance of the dorsal fin are surmounted by the usual separate neural spines. In the caudal region the vertebral centra are shorter and deeper, and some clearly alternate with and without neural and hæmal arches in the typical Amioid manner. The neural and hæmal arches are short, slender, and almost symmetrical until the base of the caudal fin, in which about 14 hæmals predominate both in length and in stoutness.

The rays of all the fins are stout and smooth, and all are both closely articulated and divided for the greater part of their length distally (Pl. XIX, fig. 5). A few short basal fulcra, increasing in length, occur at the origin of each fin, but there appear to be no fringing fulcra. Each pectoral fin seems to have comprised 9 or 10 rays, while the pelvic fin has 8 or 9 rays, which are not much more than half as long as the former. The dorsal fin occupies less than the middle third of the back, and the length of its longest rays is somewhat less than the depth of the trunk at their point of insertion. Three or four basal fulcra are distinguishable at its origin. Its 17 supports are all long and stout, expanding at the upper end where they articulate directly with the fin-rays, without the intercalation of any other supports. The anal fin, best shown in the type specimen, is comparatively small, but all its 8 supports are much elongated. The caudal fin, especially well seen in Pl. XIX, fig. 5, is very long and stout and unsymmetrically rounded, as in *Amia*. It is supported by about 14 thickened hæmal arches at the upturned end of the caudal region; and slender basal fulcral scales are conspicuous both above and below.

The deeply-overlapping scales are uniform over the whole of the trunk, longer than deep, and rounded at their free hinder border. The covered portion exhibits only the fine concentric lines of growth, but the exposed portion is thickened and finely pitted with markings which give it an irregularly reticulated appearance. This structure is especially well seen in the type specimen (Pl. XIX, fig. 6), in

Family Amiidæ.—Genus **AMIOPSIS.**

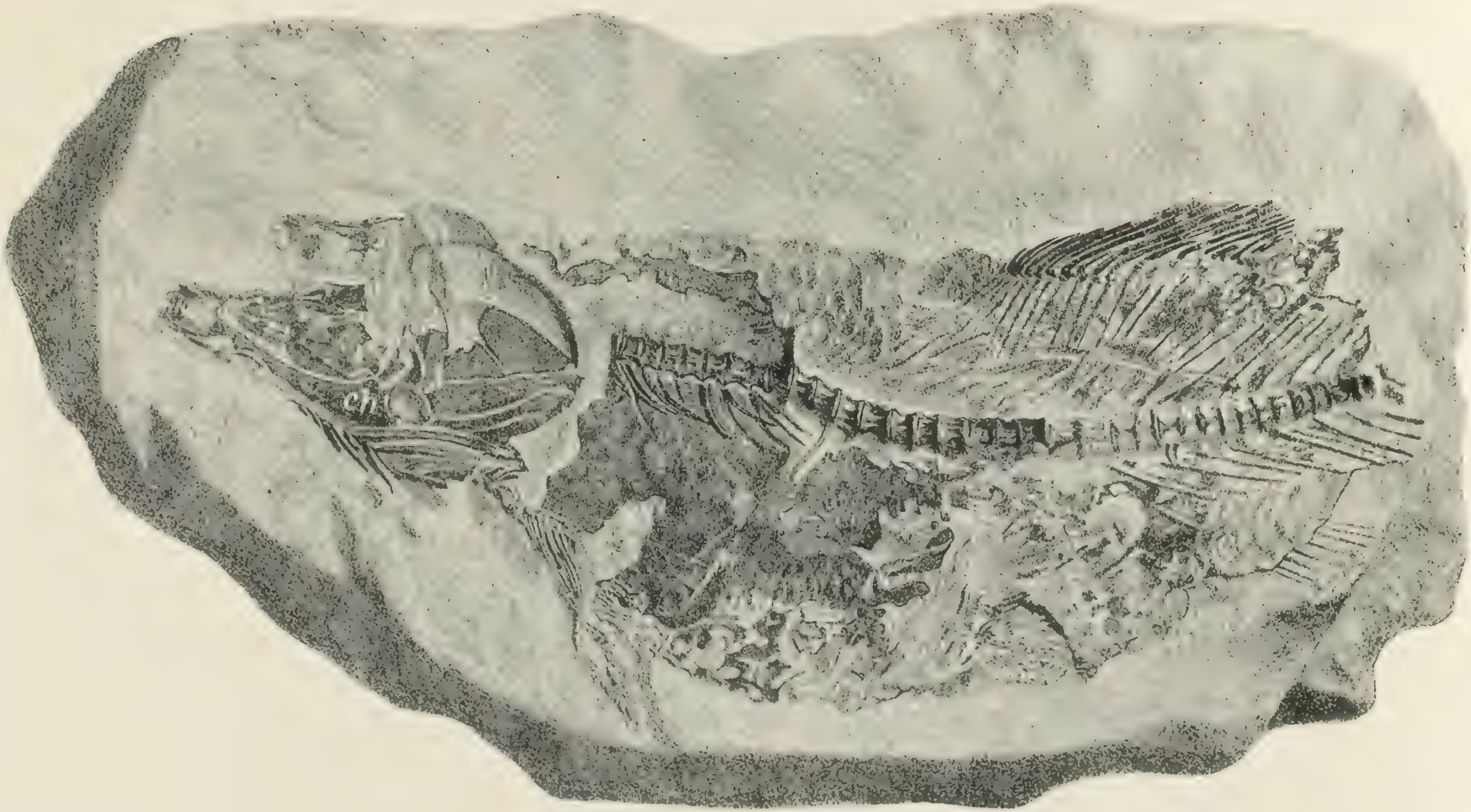


Fig. 31.—*Amiopsis austeni* (Egerton); type specimen, showing remains of head and greater part of trunk, nat. size.—Middle Purbeck Beds; Swanage, Dorset. Slightly modified, after Egerton. *ch.*, ceratohyal.

which some of the anterior scales have the pittings filled with matrix, as drawn somewhat diagrammatically in Egerton's original enlarged figure.

It may be added that in the type specimen some well-fossilised ova are scattered in the abdominal region.

Horizons and Localities.—Lower and Middle Purbeck Beds: Bincombe and Portland, near Weymouth, Dorset.

A larger form of this or another Amioid species is represented by isolated jaws in the Lower Purbeck Beds of Portland. A right maxilla, lacking teeth, is shown in outer view in Pl. XIX, fig. 7; while a left mandibular ramus, lacking the tips of the teeth, is shown from the inner aspect in Pl. XIX, fig. 8. As usual in true Amioids a few of the anterior teeth in the maxilla associated with the latter specimen are stouter than the others.

2. **Amiopsis austeni** (Egerton). Text-figure 31.

1858. *Megalurus austeni*, P. M. G. Egerton, Figs. and Descript. Brit. Organic Remains (Mem. Geol. Surv.), dec. ix, no. 9, pl. ix.
1858. *Attakeopsis (?) austeni*, V. Thiollière, Bull. Soc. Géol. France [2], vol. xv, p. 785.
1895. *Megalurus damoni*, A. S. Woodward, Catal. Foss. Fishes, B. M., pt. iii, p. 366.

Type Specimen.—Imperfect head and abdominal region; British Museum.

Specific Characters.—Imperfectly known, but head smaller, abdominal region deeper, and flank-scales deeper than in *M. damoni.*

Description of Specimen.—This species is still known only by the imperfect and somewhat distorted type specimen (Text-fig. 31). The other fragments, mentioned by Egerton as abundant, are evidently referable to Leptolepidæ. Traces of stout styliform teeth, with a blunt apex, sometimes slightly curved, are seen in both jaws. Remains of the opercular apparatus, much broken, are exposed from within, and a few broad branchiostegal rays occur below them, with the greater part of the supporting epihyal and ceratohyal (*ch.*). The vertebral centra clearly exhibit their lateral pitting, and the short curved ribs are observed to be rather stout. In the anterior part of the caudal region, only alternate centra bear arches. The paired fins are very imperfect, but remains of both occur nearly in their original position, the pectorals being especially large. The dorsal fin has the usual three or four gradually lengthening basal fulcra at its origin. The small anal fin is only partly shown in impression. The comparatively deep scales, with rounded posterior border, are best seen in the upper anterior part of the abdominal region. As in the type specimen of *A. damoni*, there seem to be some fossilised ova.

Horizon and Locality.—Middle Purbeck Beds: Swanage, Dorset.

Family Aspidorhynchidæ.

Genus **ASPIDORHYNCHUS**, Agassiz.

Aspidorhynchus, L. Agassiz, Poiss. Foss., vol. ii, pt. i, 1833, p. 14.

Generic Characters.—Rostrum slender, much produced in advance of mandibular symphysis; circumorbital plates very small, postorbitals large; teeth irregular in size, largest on the premaxilla, palatine, and presymphysial bone, reduced to a fine granulation on the inner face of the ectopterygoid; branchiostegal rays short and broad, and gular plate apparently absent. Vertebral centra in form of rings. Fulcra wanting on paired fins, minute on median fins. Pelvic fins situated at about the middle of the trunk; dorsal and anal fins short-based, triangular, remote

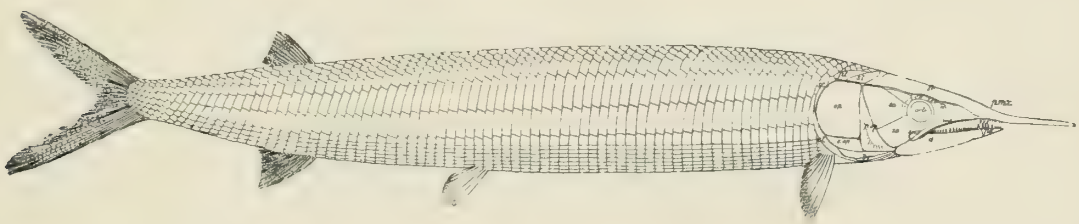


Fig. 32.—*Aspidorhynchus acutirostris* (Blainville); restoration, about one-seventh nat. size.—Lower Kimmeridgian (Lithographic Stone); Bavaria. *br.*, branchiostegal rays; *cl.*, clavicle; *co.*, circumorbitals; *d.*, dentary; *fr.*, frontal; *mx.*, maxilla; *n.*, narial opening; *op.*, operculum; *orb.*, orbit; *pmx.*, premaxilla; *p.op.*, preoperculum; *ps.*, presymphysial; *pt.*, post-temporal; *scl.*, supraclavicle; *smx.*, supramaxilla; *so.*, postorbitals; *s.op.*, suboperculum; *st.*, supratemporal.

and opposed; caudal fin symmetrically forked. Scales robust, smooth or rugose; in two or three deepened series on the flank of the abdominal region, and the foremost scales of the series traversed by the lateral line not deeper than the series below.

Type Species.—*Aspidorhynchus acutirostris* (L. Agassiz, Poiss. Foss., vol. ii, 1833–44, pt. i, p. 14, pt. ii, p. 136, pl. xlvi; *Esox acutirostris*, H. D. de Blainville, Nouv. Dict. d'Hist. Nat., vol. xxvii, 1818, p. 332), from the Lithographic Stone (Lower Kimmeridgian) of Bavaria (Text-fig. 32).

Remarks.—Reis[1] supposed that *Aspidorhynchus* was distinguished from the closely related and partly contemporaneous genus *Belonostomus*, by the intercalation of a supplementary triangular cheek-plate between its upper postorbital and the preoperculum. This determination was adopted both by Zittel[2] and the present writer,[3] but it is now clear that the appearance of such a separate plate is

[1] O. M. Reis, 'Ueber *Belonostomus, Aspidorhynchus,* und ihre Beziehungen zum lebenden *Lepidosteus,*' Sitzungsb. k. bayer. Akad. Wiss., math.-phys. Cl., vol. xvii (1887), p. 173, pl. ii, fig. 7.

[2] K. A. von Zittel, Handbuch der Palæontologie, vol. iii (1887), p. 220, fig. 233.

[3] A. S. Woodward, Catal. Foss. Fishes, Brit. Mus., pt. iii (1895), p. 418, text-fig. 42.

due merely to the crushing of the external bones on those beneath.[1] An amended restoration of the type species, *A. acutirostris*, is accordingly given in Text-fig. 32.

Since the last description of *Aspidorhynchus*, two specimens of the skull probably of this genus (but possibly of the closely allied *Belonostomus*), from the Great Oolite of Northampton, have been found to display clearly several of the cranial bones. It is thus interesting to observe the large proportions and median union of the epiotic elements, which have already been described in *Lepidotus* (p. 38). Above the large exoccipitals which meet over the foramen magnum on the occipital face (Text-fig. 33 B, *exo.*), the two epiotics (*epo.*), though slightly obscured by crushing in the matrix, evidently also meet in the middle line. In upper view, however (Text-fig. 33 A), they are clearly seen to be separated forwards

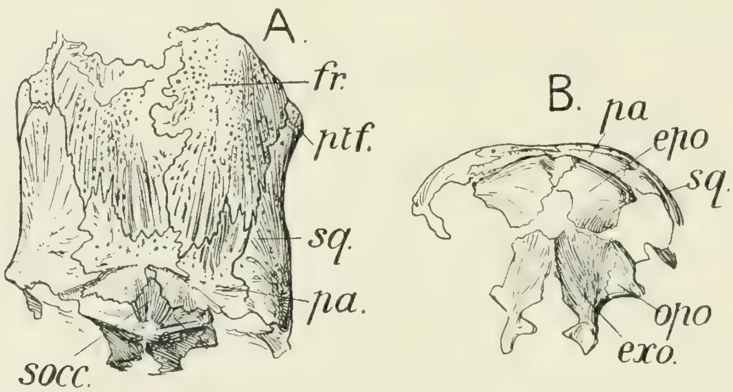


FIG. 33.—*Aspidorhynchus* sp.; imperfect hinder portion of skull, upper view (A) and back view (B), nat. size.—Lower Jurassic (Great Oolite); Kingsthorpe, Northampton. T. Jesson Collection (B. M. no. P. 9843). *epo.*, epiotic; *exo.*, exoccipital; *fr.*, frontal; *opo.*, opisthotic; *pa.*, parietal; *ptf.*, postfrontal (sphenotic); *socc.*, supraoccipital; *sq.*, squamosal. In back view (B) the supraoccipital is not shown, the triangular space between the upper ends of the epiotics being occupied by matrix.

by a small median element of the same texture, which is doubtless an ossified supraoccipital (*socc.*). The very irregular parietals (*pa.*), which overlap these elements, occupy only a small portion of the occipital end of the cranial roof; and their hinder half is depressed and smooth, showing that it was originally covered by the muscles. The relatively large frontal bones (*fr.*), which meet in a very wavy median suture, thus extend far backwards; and the squamosals (*sq.*) are likewise much extended, forming the roof of a large post-temporal cavity, of which the opisthotic (Text-fig. 33 B, *opo.*) makes the floor behind. The small postfrontals or sphenotics (*ptf.*) also seem to be exposed on the cranial roof. In the second specimen (B. M. no. P. 9844) there is a pair of large alisphenoids, pierced by several foramina; and the comparatively small but well-ossified orbitosphenoids meet below, completely enclosing the anterior extension of the cerebral cavity.

[1] P. Asmuss, 'Ueber *Aspidorhynchus*,' Archiv für Biontologie, vol. i. (1906), p. 55, pl. vi, and text-fig. 1.

1. **Aspidorhynchus fisheri,** Egerton. Plate XX, figs. 1—4.

1854. *Aspidorhynchus fisheri*, P. M. G. Egerton, Ann. Mag. Nat. Hist. [2], vol. xiii, p. 434.
1855. *Aspidorhynchus fisheri*, P. M. G. Egerton, Figs. and Descripts. Brit. Organic Remains (Mem. Geol. Surv.), dec. viii, no. 6, pl. vi.
1880. *Aspidorhynchus fisheri*, A. Günther, Introd. Study of Fishes, p. 369, fig. 146.
1895. *Aspidorhynchus fisheri*, A. S. Woodward, Catal. Foss. Fishes, Brit. Mus., pt. iii, p. 425.

Type.—Nearly complete fish; Dorset County Museum, Dorchester.

Specific Characters.—A slender species attaining a length of about 40 cm. Maximum depth of trunk equalling about half the length of the head with opercular apparatus, which is comprised nearly four-and-a-half times in the total length of the fish. Cranium rapidly tapering to the acute rostrum, which is produced in advance of the mandible to an extent equalling one-third of the total length of the cranium; cranial bones and cheek-plates ornamented with fine granulations, which are fused into longitudinal rugæ on the rostrum and sometimes fused or raised on ridges on part of the cranial roof; mandible and opercular bones almost smooth, the former only marked by the openings of the slime-canal; presymphysial bone very short, scarcely longer than deep; mandibular teeth comparatively stout. Pelvic fins arising midway between the pectorals and the caudal. Scales smooth or very feebly rugose, except those of the dorsal region, which are marked with longitudinal rugæ.

Description of Specimens.—The type specimen (Pl. XX, fig. 1) shows the general proportions of the fish, but it is much broken and flaked, and various details of structure are better seen in the other specimens. It exhibits portions of all the fins, indicating their relative positions. It also displays well the arrangement of the scales.

The rostrum, which is closely ornamented with longitudinal ridges, is apparently complete in the type specimen and must have occupied about one-third of the total length of the skull. The rest of the skull, however, and the mandible are better seen in a smaller fossil in the British Museum (enlarged in Pl. XX, fig. 2). The greater part of the cranial roof is formed by the large frontal bones (*fr.*), which are united in a very wavy median suture, and are only slightly excavated at the outer edge by the orbits. They are externally ornamented by fine tubercles, which are arranged in radiating lines, sometimes on ridges, sometimes themselves fused into short ridges. They are also marked along each outer border by the groove and series of pores forming the openings of the slime-canal. The parietals (*pa.*) are short and broad, crossed behind by the groove of the transverse slime-canal, and ornamented with tubercles which are more or less fused into antero-posterior ridges. A crushed mass (*x.*) behind the parietals is probably to be interpreted as the fused epiotics. A slender parasphenoid (*pas.*) is seen crossing the orbit. Of

the cheek-plates, there are traces of the large postorbitals, ornamented with a few sparse tubercles; and above them is the characteristic triangular postero-superior circumorbital, similarly ornamented and traversed by the deep groove of the slime-canal with its short posterior branchlets. An antero-superior circumorbital, also apparently of triangular shape, is finely tuberculated; but a small anterior circumorbital, traversed by the slime-canal, is smooth. Remains of an ossified sclerotic ring are distinct.

As shown both by the type specimen and by the original of Pl. XX, fig. 2, the hyomandibular (*hm.*) is an expanded lamina strengthened in the middle by a vertical rod-shaped ridge; and there is a small symplectic (*sy.*) of the *Amia*-type, widest at the upper end, behind the thin, fan-shaped quadrate (*qu.*). The entopterygoid is covered with a cluster of minute, almost granular teeth. The ectopterygoid seems to have borne very small conical teeth. The long and slender maxilla (*mx.*) is gently curved downwards behind, where it is overlapped by a single small supramaxilla (*smx.*). Its external face is smooth, and its upper border, just in front of the orbit, rises as usual into a broad laminar process. Its oral border bears a row of small conical teeth, which are smallest and curved forwards in the hinder portion. The premaxilla (*pmx.*) seems to have been fused with the base of the rostrum, and its recurved conical teeth diminish in size forwards. The mandible is deep in proportion to its length, and its articulo-angular portion (*ag.*) is very short. The dentary (*d.*) is about three times as deep at its hinder end as at its truncated symphysis. The outer face both of the angular and of the dentary is nearly smooth, only marked by the conspicuous slime-canal, which is defined above by a ridge and fringed below by a series of short branchlets. The oral border of the dentary bears a single regular series of large, smooth, and stout conical teeth, which are flanked near the symphysis by a short row of comparatively small conical teeth. Similar small teeth are also seen in the type specimen on the upper edge of the displaced splenial bone. The presymphysial bone (*ps.*) is imperfect in the type specimen, but well preserved in the original of Pl. XX, fig. 2. It is triangular in shape, not much longer than deep, and nearly smooth on its outer face. Its oral border bears a row of smooth conical teeth, which decrease in size forwards.

The operculum (*op.*), which must have been about as broad as deep, is nearly smooth, only marked by some sparse minute tubercles. The other opercular bones and the branchiostegal rays have not been well seen, but the preoperculum seems to have had the usual triangular expansion of its lower portion. As already noted by Egerton, the removal of the operculum in the type specimen exposes remains of the slender branchial arches, which bear a widely-spaced series of slender gill-rakers (fig. 1*a*).

The smooth cylindrical vertebral centra are crushed flat in the fossils but seem to have been about as long as deep throughout the whole length of the axis.

Traces of short slender ribs occur both in the type specimen and in the original of Pl. XX, fig. 2; and the other vertebral arches are also evidently delicate.

Of the pectoral arch only the clavicle has been clearly observed. This bone (Pl. XX, fig. 2, *cl.*) is much arched, with the upper and lower limbs about equal in length, but the lower the wider. Its exposed portion is very narrow, smooth only at its hinder margin, conspicuously marked by fine longitudinal ridges anteriorly. The hinder border is slightly notched at the insertion of the pectoral fin, where there are traces of a well-ossified scapula or coracoid. There appear to be no specially modified postclavicular scales. The pectoral fin (*pct.*), of which only the base is known, comprises at least 10 smooth rays, of which most are very broad and deeply overlapping. The position of the small pelvic fins is indicated in the type specimen (Pl. XX, fig. 1, *plv.*); but it can only be stated that their rays are smooth and broad, with distant articulations at the distal end. The dorsal (*d.*) and caudal fins are known only by fragments in the same specimen; but the anal fin (*a.*) is better preserved, exhibiting at least 20 rays, of which the length of the foremost is nearly equal to the depth of the tail at its insertion. The anal fin-rays are smooth, divided, and distantly articulated in their distal half, and apparently less crowded than the rays of the paired fins. The foremost ray seems to bear traces of a fringe of minute fulcra.

The total number of transverse series of scales in the type specimen seems to have been slightly more than seventy, and they are seen to be arranged as in the typical species of *Aspidorhynchus* from the Lithographic Stone of Bavaria. Those of the abdominal region are best displayed in outer view in a fragment of which part is represented in Pl. XX, fig. 3. All the scales are deeply overlapping, and their hinder border is not serrated though sometimes slightly wavy. The rhombic dorsal scales throughout the trunk (Pl. XX, figs. 1*b*, 4) are covered with conspicuous smooth ridges, variously wavy and sometimes bifurcating, which run diagonally. The other scales, though also well enamelled, are only faintly and finely rugose. In each transverse series of the abdominal region there are two of the ornamented rhombic scales at the upper end, and there seems to have been a similarly ornamented median dorsal ridge-scale. The two principal scales of the flank are about equal in depth, and the upper of these is crossed near its forwardly curved upper end by the slime-canal, which notches the hinder border and occasionally opens by a pore on the middle of the scale. The next lower scale is almost square, less than half as deep as the principal flank-scales. Six, sometimes seven, very narrow scales complete the series below, the lowest being a sharp-edged ridge-scale without any serration. In the caudal region the flank-scales gradually become less deepened, until on the caudal pedicle they are rhombic and nearly uniform in size. There appear to be no enlarged ridge-scales. When exposed from within (Pl. XX, figs. 1, 2), all the scales of the abdominal region are shown to be united by a very

large peg-and-socket articulation, and their inner face is strengthened by a wide vertical ridge. In the caudal region this articulation gradually disappears.

Horizon and Locality.—Middle Purbeck Beds: Swanage, Dorset.

Genus **BELONOSTOMUS**, Agassiz.

Belonostomus, L. Agassiz, Neues Jahrb. für Min., etc., 1834, p. 388.
Ophirhachis, O. G. Costa, Ittiol. Foss. Ital., 1856, p. 13.
Diphyodus, L. M. Lambe, Contrib. Canadian Palæont., vol. iii, pt. ii, 1902, p. 30.

Generic Characters.—As *Aspidorhynchus*, but mandible almost or quite as long as the rostrum, and all the scales of the lateral line deeper than those immediately beneath.

Type Species.—*Belonostomus sphyrænoides* (L. Agassiz, Poiss. Foss., vol. ii, pt. ii, 1844, pp. 140, 297, pl. xlvii *a*, fig. 5), from the Lithographic Stone (Lower Kimmeridgian) of Bavaria.

1. **Belonostomus hooleyi**, sp. nov. Plate XXI, figs. 1—3.

Type.—Imperfect principal scale of flank; collection of Reginald W. Hooley, Esq.

Specific Characters.—Principal deepened scale of flank smooth, sometimes with traces of large elongated tubercles near the anterior border, and marked by one conspicuous vertical groove; the posterior border very coarsely and irregularly crenulated and pectinated. Dorsal scales ornamented with a few large, low, and irregular short longitudinal ridges. Roof of skull with similar coarse ornament.

Description of Specimens.—The type scale (Pl. XXI, fig. 1) is incomplete below, and most of its smooth outer surface has been flaked away; but it is well preserved at the forwardly bent upper end, where the slightly tumid anterior half is clearly separated by a sharp vertical line from the flatter posterior half. At the upper end the posterior border seems to be entire, but below this it is very coarsely and irregularly crenulated, each prominence being bluntly pointed and forming a slight horizontal ridge.

The same form of flank-scale is distinguishable in the fragmentary pyritised remains of a fish in the Mantell Collection, which also includes the hinder half of a cranium and traces of vertebræ. The flattened roof of the skull must have been very coarsely ornamented with irregular rounded ridges and low elongated tubercles. All the otic bones and apparently the alisphenoid are well ossified; and an anterior vertebral centrum, evidently fused with the basioccipital, is more extensively ossified than the ordinary vertebral centra of *Aspidorhynchus*. Another centrum among the scales shows that it is pierced in the middle for a persistent strand of the notochord. The rhombic dorsal scales (Pl. XXI, fig. 2) are as coarsely ornamented

with rounded ridges as the bones of the cranial roof. They are deeply overlapping, and their irregular ornamental ridges tend to be diagonal in direction.

Remarks.—The fragmentary remains thus described are referred to *Belonostomus* rather than to *Aspidorhynchus*, on account of the stout ossification of the vertebral centra and the vertical grooving of the principal flank-scales. They are distinguished from the remains of all known species by the peculiar crenulation of the posterior border of the principal flank-scales. The specific name now proposed for them is given in honour of Mr. Reginald W. Hooley, F.G.S., whose important discoveries in the Wealden of the Isle of Wight are well known.

Horizon and Localities.—Wealden: Isle of Wight, probably also Sevenoaks, Kent (small scale in Sedgwick Museum, Cambridge, shown enlarged in Pl. XXI, fig. 3).

Family PHOLIDOPHORIDÆ.

Genus **PHOLIDOPHORUS**, Agassiz.

Pholidophorus, L. Agassiz, Neues Jahrb. für Min., etc., 1832, p. 145.
(?) *Microps*, L. Agassiz, Poiss. Foss., vol. ii, pt. i, 1833, p. 10.

Generic Characters.—Trunk fusiform, not much deepened, and head relatively large. External bones smooth or delicately ornamented with rugæ and tuberculations; slime-canal on cheek-plates branched; maxilla more or less arched, the oral margin convex or nearly straight, with small conical or styliform teeth; mandibular teeth slightly larger, in single series. Lower expansion of preoperculum marked by radiating furrows; suboperculum large, but smaller than the trapezoidal operculum, from which it is divided by an oblique suture; interoperculum triangular and well forwards; branchiostegal rays numerous. Pleurocentra and hypocentra round notochord fused or separate. Fulcra present on all the fins. Pectoral fins of moderate size, but larger than the pelvic pair; dorsal and anal fins triangular, not extended, the former opposite to or arising somewhat behind the pelvic fins; caudal fin deeply forked. Squamation complete; scales thin and deeply overlapping, usually with an inner rib and peg-and-socket articulation, and the external ganoine smooth or feebly ornamented; principal flank-scales deeper than broad, ventral scales in part broader than deep; no enlarged series of ridge-scales. Lateral line conspicuous.

Type Species.—*Pholidophorus bechei* (L. Agassiz, Poiss. Foss., vol. ii, pt. i, 1844, p. 272, pl. xxxix, figs. 1—4), from the Lower Lias of Lyme Regis, Dorset. Additional details in Catal. Foss. Fishes, Brit. Mus., pt. iii (1895), p. 450, pl. xii, figs. 1, 2.

Remarks.—Representatives both of the pectinate-scaled and of the smooth-scaled forms of *Pholidophorus* occur in the Purbeck Beds. They are remarkable for the stoutness of the fulcra on the fins.

1. **Pholidophorus ornatus**, Agassiz. Plate XX, figs. 5—8; Plate XXI, fig. 1; Text-figure 34.

1843–44. *Pholidophorus ornatus*, L. Agassiz, Poiss. Foss., vol. ii, pt. i, p. 280, pl. xxxvii, figs. 6, 7.
1855. *Pholidophorus ornatus*, P. M. G. Egerton, Figs. and Descripts. Brit. Organic Remains (Mem. Geol. Surv.), dec. viii, no. 4, p. 1, pl. iv, fig. 3.
1895. *Pholidophorus ornatus*, A. S. Woodward, Catal. Foss. Fishes, Brit. Mus., pt. iii, p. 471.

Type.—Imperfect tail; British Museum.

Specific Characters.—Attaining a length of about 20 cm. Length of head with opercular apparatus nearly equal to the maximum depth of the trunk and occupying between one-quarter and one-fifth of the total length of the fish. Head and opercular bones very feebly rugose or smooth; maxilla not much arched; teeth obtusely pointed. Fin-rays smooth and stout, and fulcra comparatively large. Pelvic fins arising midway between the pectoral and anal fins, and opposed to the dorsal fin, of which the length of the longest ray about equals the depth of the trunk at its insertion. Scales ornamented with coarse oblique pectinations ending in sharp serrations; about six flank-scales in each abdominal transverse series deeper than broad; lateral line marked by notches on the scales in the abdominal region, forming a sharp smooth ridge on the scales in the hinder part of the caudal region.

Description of Specimens.—The type specimen in the Mantell Collection (Pl. XX, fig. 5) exhibits only the imperfect caudal region, and is very unsatisfactorily described and figured by Agassiz, *loc. cit.* The thin cylindrical vertebral centra (*c.*) are seen, though crushed, near the base of the caudal fin, while the comparatively short and stout neural and hæmal arches are shown to be sharply inclined backwards and thus deeply overlapping. A fragment of the pelvic fin (*plv.*) proves that it was rather large. The small anal fin (*a.*) bears a close series of short and slender fulcra. The dorsal fin is absent, though false appearances of it were misinterpreted and described by Agassiz. The stout rays of the forked caudal fin are enamelled, and with rather distant articulations. Its fringing fulcra are small and in very close series. The scales exhibit the characteristic pectination of the posterior border even to the base of the caudal fin; and there is one enlarged, elongated dorsal ridge-scale, with faint rugose ornament, at the origin of the upper caudal lobe. Traces of a smooth longitudinal keel are seen on some of the scales of the lateral line.

Other specimens now exhibit nearly all the principal characters of the genus and species, and one small fish (Pl. XX, fig. 6), discovered by Mr. Alexander J. Hogg, is especially fine, only crushed and incomplete towards the end of the tail.

The abdominal region must have been rather stout, not much laterally compressed, for it is often exposed from below (Pl. XXI, fig. 4) or distorted by crushing in the fossils. Its ventral face must have been nearly flat.

The postorbital part of the cranial roof is somewhat wider than long, and the frontal region between the orbits is also comparatively wide. Except the narrow overlapped margin at its straight occipital border, the roof is closely ornamented with a very fine and inconspicuous rugosity; the short parietals and squamosals are crossed by a groove for the transverse slime-canal, and the frontals are pitted along the outer margin by the openings of the longitudinal slime-canal (B. M. no. 28446). A large elongate-oval nasal bone, also ornamented, occurs in front of the frontal (B. M. no. P. 10011). There is much ossification in the otic region; and the parasphenoid bone is stout, bearing an elongated cluster of minute teeth between and just in front of its lateral processes (B. M. no. 28445).

The large orbit is surrounded by a ring of thin, smooth cheek-plates, traversed

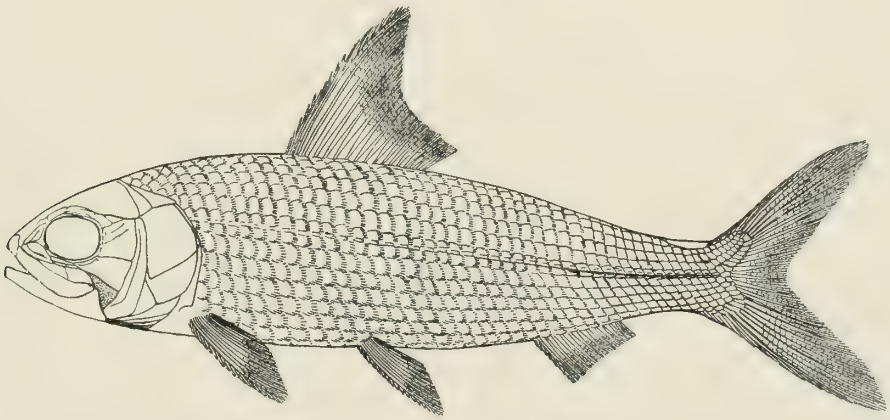


FIG. 34.—*Pholidophorus ornatus*, Agassiz; restoration, about half nat. size.—Middle Purbeck Beds; Swanage. The cheek-plates partly restored from *Pholidophorus micronyx*, Ag.

by a very large slime-canal, from which a few long branchlets radiate on the postorbitals and preorbitals. There is an ossified sclerotic ring.

In the mandibular suspensorium the hyomandibular is much expanded, and the small quadrate is cleft behind as if for clasping a symplectic. The entopterygoid is a thin lamina of bone, and a cluster of minute teeth in B. M. no. 28446 may have belonged to it. The maxilla (Pl. XX, fig. 6 *a*, *mx.*) and premaxilla (*pmx.*) are comparatively stout bones with a smooth or only faintly rugose outer face. The maxilla is a narrow band of bone curved upwards at its hinder end, where it is deepest, and not much contracted at its anterior end, where it bears a slender upwardly-directed process for attachment to the inner face of the premaxilla and doubtless also to the palatine (especially well seen in Mus. Pract. Geol. no. 28438). Its oral border is nearly straight, bearing a single close regular series of small and blunt styliform teeth; its upper border, throughout the greater part of its length, is overlapped by two thin and nearly smooth supramaxillary plates (*smx.*), the

posterior being the smaller and triangular in shape with a short antero-superior process, the anterior elongate-triangular slowly tapering to a point in front. The premaxilla has an oral border scarcely more than one-quarter as long as that of the maxilla, but its styliform teeth are somewhat larger; its upper portion near the middle line of the snout rises into a process for articulation with the ethmoidal region of the skull. The mandible tapers gradually from the low coronoid elevation behind to the bluntly pointed symphysis in front. The articulo-angular bone (*ag.*) is very short, with its finely rugose ornament slightly more conspicuous than that of the dentary (*d.*), which is marked chiefly by the row of large pores along the course of the slime-canal. Its blunt teeth, which are somewhat stouter than those of the maxilla, seem to be in more than one series at the symphysis.

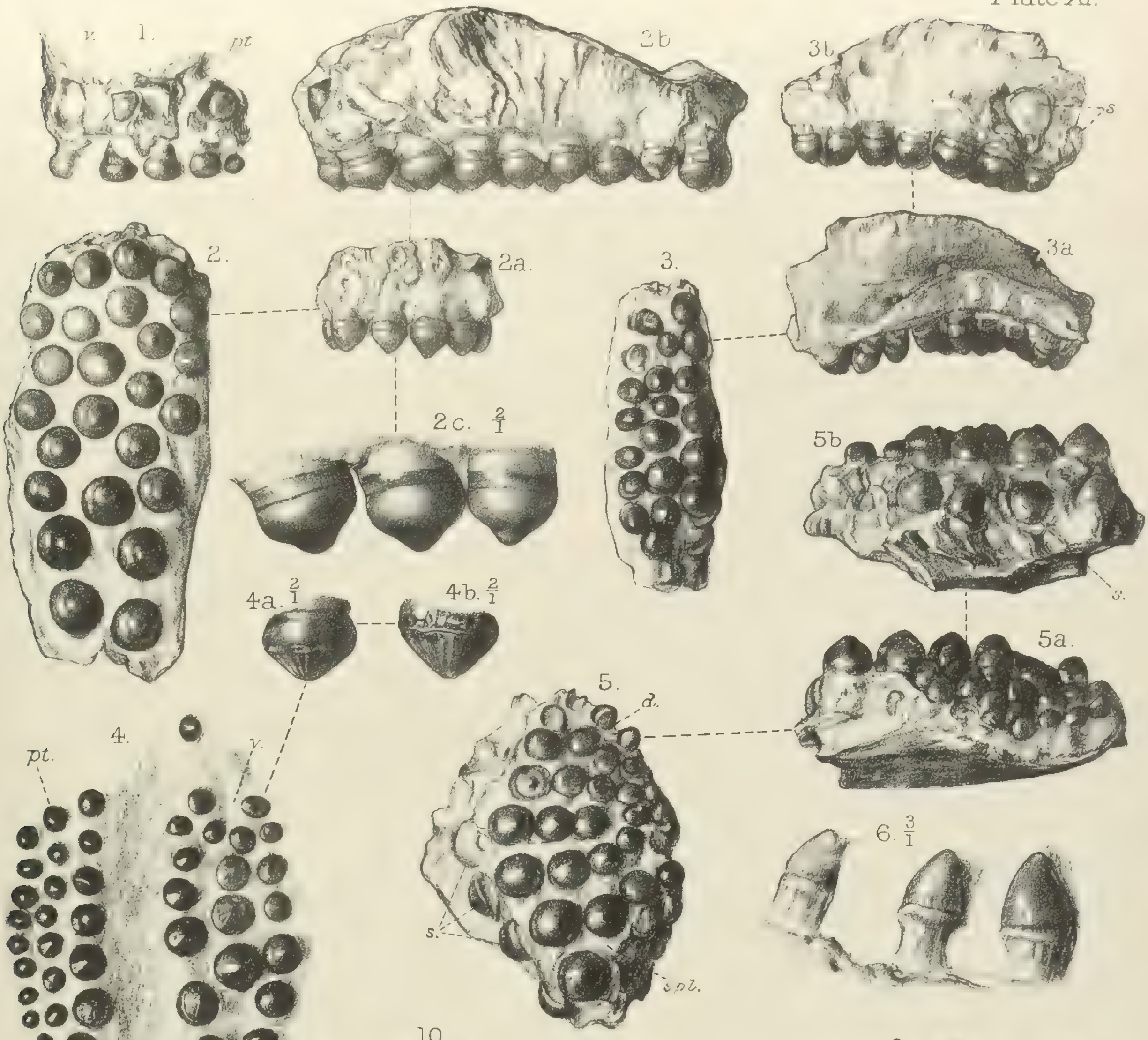
The opercular bones are so thin that they are usually much broken in the fossils, and their fine rugose ornament is so delicate that it is often destroyed. The operculum (Pl. XX, fig. 6; Pl. XXI, fig. 4, *op.*) is a little deeper than wide and slightly more than twice as deep as the suboperculum (*sop.*), which bears a conspicuous sharply pointed antero-superior process. The triangular interoperculum (*iop.*) is relatively large. The preoperculum (*pop.*), which tapers upwards nearly to the upper limit of the operculum, is a narrow plate, not much expanded at its blunt angle, and almost without a horizontal limb. It is traversed by a very large slime-canal, from which a few branchlets radiate backwards over the lower expansion. The upper branchiostegal rays (*br.*) are large and finely rugose, and all these rays seen in the fossils, not less than 16 pairs in regular series, are rather broad laminæ.

The delicate vertebral rings in the caudal region, with their short recumbent neural and hæmal arches, in the type specimen, have already been mentioned. Other specimens show that the centra are represented only by rings throughout the vertebral axis; and in some cases a ring appears to consist of two separate parts, a pleurocentrum above and a hypocentrum below (B. M. no. P. 3605 *a*). The ribs are short and slender (B. M. no. 43038).

The supratemporal and post-temporal plates have not been well observed, but they are evidently thin and very faintly rugose. The supraclavicle (Pl. XXI, fig. 4, *scl.*) is about three times as deep as wide, and crossed obliquely by the large slime-canal, above which its posterior margin is enamelled and pectinated. The sigmoidally bent clavicle (*cl.*) is nearly smooth in its narrow exposed portion, but rises into a triangular rugose boss just beneath the notch for the insertion of the pectoral fin, and then passes below into a large smooth expansion where it is covered. The postclavicular plates, or perhaps anterior scales, are smooth for the greater part of their width, but pectinated and serrated at their posterior margin. The pectoral fin (Pl. XXI, fig. 4, *pct.*) comprises about 20 rays, all articulated and divided distally, and the foremost fringed with a close series of small, deeply overlapping fulcra. The pelvic fins (*plv.*), which are inserted

PLATE XI.

Fig.		Page.
1.	*Lepidotus mantelli*, Agassiz; anterior end of vomer (*v.*) and left pterygo-palatine (*pt.*) in cross-section, anterior view, to show successional teeth in sockets, nat. size.—Wealden; Hastings. Beckles Collection (B. M. no. P. 6342).	42.
2.	Ditto; vomer, oral, anterior (2 *a*), and right lateral (2 *b*) views, nat. size, with three anterior teeth (2 *c*), enlarged twice to show mammilliform apex.—Ibid. Beckles Collection (B. M. no.P. 6363).	42.
3.	Ditto; right pterygo-palatine, oral, outer (3 *a*), and inner (3 *b*) views, nat. size; *s.*, successional teeth in sockets.—Ibid. Dawson Collection (B. M. no. P. 4917).	41.
4.	Ditto; vomerine (*v.*) and right pterygo-palatine (*pt.*) dentition, oral view, nat. size, with two teeth in side view (4 *a*, 4 *b*), enlarged twice to show wrinkled gano-dentine.—Wealden; Isle of Wight. British Museum, no. 47504.	43.
5.	Ditto; imperfect right splenial (*spl.*) and dentary (*d.*), oral, outer (5 *a*), and inner (5 *b*) views, showing successional teeth (*s.*) in broken section of bone, nat. size.—Wealden; Tilgate Forest. Mantell Collection, no. 2326.	42.
6.	Ditto; three teeth of right dentary bone, outer view, three times nat. size.—Wealden; Hastings. J. E. Lee Collection (B. M. no. P. 4995).	42.
7.	Ditto; middle flank-scale, outer view, nat. size.—Ibid. Dawson Collection (B. M. no. P. 4916).	47.
8.	Ditto; middle flank-scale, inner view, nat. size.—Wealden; Tilgate Forest. Mantell Collection, no. 2397.	47.
9, 10.	Ditto; upper flank-scales of abdominal region, outer view, and second in inner view (10 *a*), nat. size.—Ibid. Mantell Collection, nos. 3036, 3092.	47.
11, 12.	Ditto; lower flank-scales of abdominal region, outer view and inner view (11 *a*, 12 *a*), nat. size.—Ibid. Mantell Collection, nos. 3089, 3045.	47.
13.	Ditto; caudal scale, outer and inner view (13 *a*), nat. size.—Ibid. Mantell Collection (B. M. no. 26009).	47.
14.	Ditto; caudal scale of lateral line, outer and inner view (14 *a*), nat. size.—Ibid. Mantell Collection.	47.



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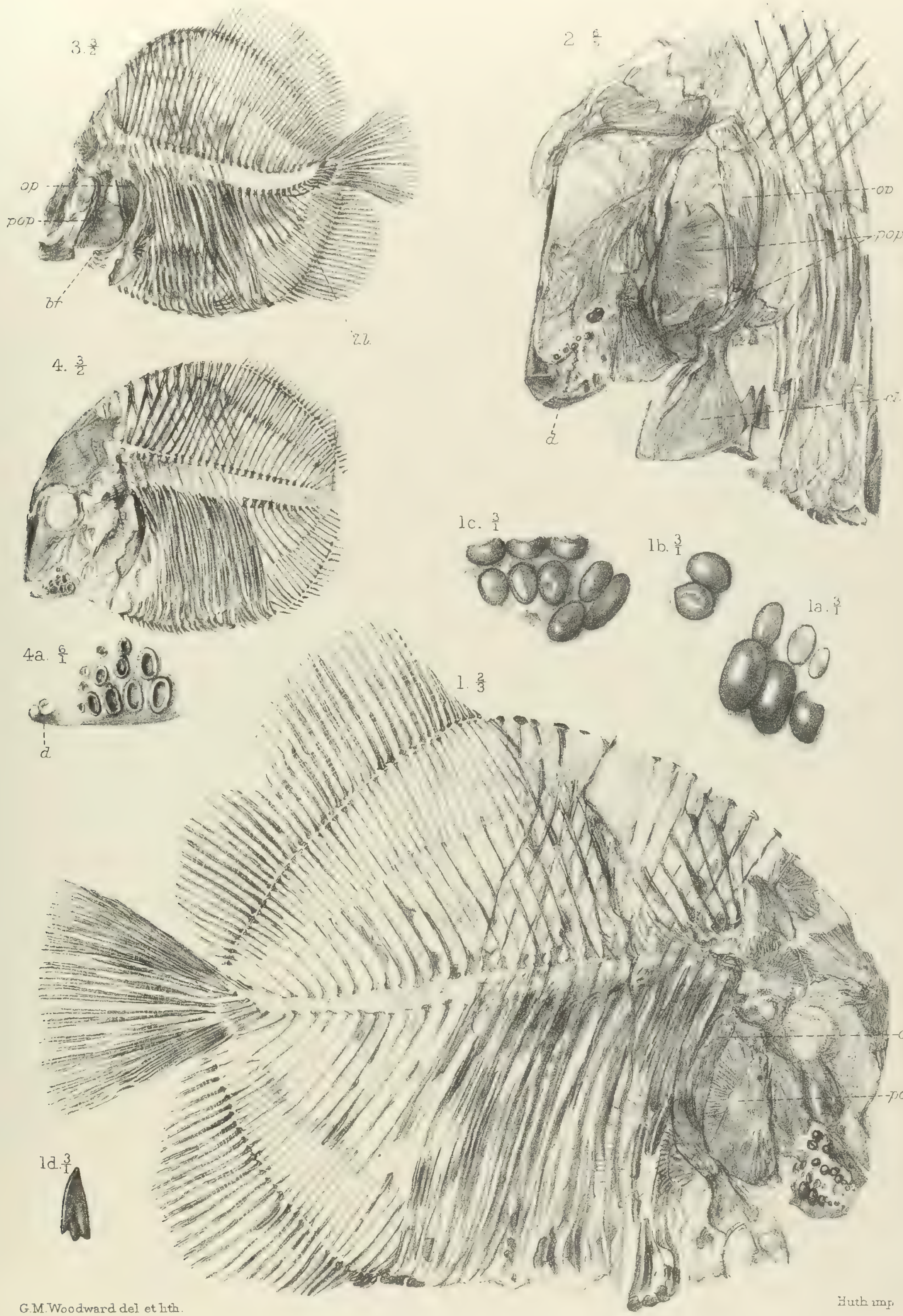
Lepidotus

PLATE XII.

Fig. | Page.

1. *Mesodon daviesi*, A. S. Woodward; nearly complete fish, two-thirds nat. size, with some splenial teeth (1 *a*), two vomerine teeth (1 *b*), other teeth from the counterpart (1 *c*), and the caudal scale (1 *d*), enlarged three times.—Middle Purbeck Beds; Swanage, Dorset. The type specimen. British Museum, nos. 41387, P. 6381. *op.*, operculum; *pop.*, preoperculum. 50.
2. Ditto; crushed head and anterior abdominal region, six-fifths nat. size. —Ibid. Enniskillen Collection (B. M. no. P. 4381). *cl.*, clavicle; *d.*, dentary; *op.*, operculum; *pop.*, preoperculum of both sides, the right from within, the left imperfect. 51.
3. *Mesodon parvus*, A. S. Woodward; fish, lacking head, three-halves nat. size.—Middle Purbeck Beds; Teffont, Wiltshire. The type specimen. Rev. W. R. Andrews Collection (B. M. no. P. 9845). *br.*, branchiostegal rays; *l.l.*, calcifications along lateral line; *op.*, operculum; *pop.*, preoperculum. 52.
4. Ditto; fish, lacking tail, three-halves nat. size, with part of mandible (4 *a*) showing dentary (*d.*) and basal rim of splenial teeth, enlarged six times.—Ibid. T. T. Gething Collection (B. M. no. P. 10954). 53.



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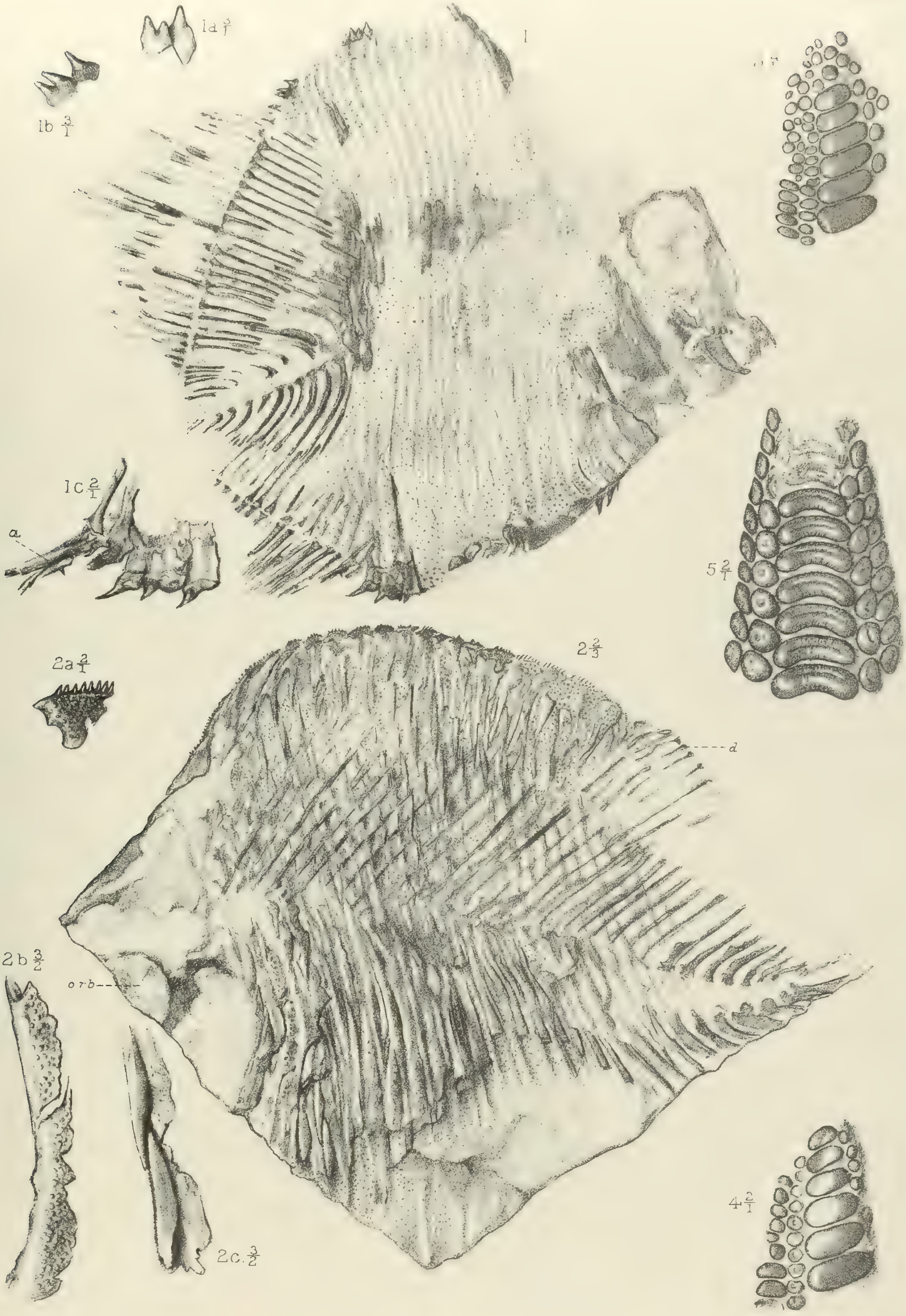
Mesodon.

PLATE XIII.

Fig.		Page.
1.	*Eomesodon barnesi*, A. S. Woodward; imperfect fish, nat. size, with denticles of dorsal ridge-scales (1 *a*, 1 *b*) enlarged three times, and ventral ridge-scales (1 *c*) with anterior anal fin-rays (*a*.) enlarged twice.—Middle Purbeck Beds; Swanage, Dorset. Beckles Collection (B. M. no. P. 6382).	57.
2.	*Eomesodon depressus*, sp. nov.; imperfect fish, two-thirds nat. size, with a dorsal ridge-scale (2 *a*) enlarged twice, two flank-scales, outer view (2 *b*) and inner view (2 *c*), three-halves nat. size.—Ibid. The type specimen. British Museum, no. P. 10583. *d*., supports of dorsal fin; *orb*., orbit.	57.
3.	*Mesodon* sp.; left splenial dentition, oral view, twice nat. size.—Ibid. Enniskillen Collection (B. M. no. P. 3757).	58.
4.	*Mesodon* sp.; left splenial dentition, oral view, twice nat. size.—Ibid. Museum of Practical Geology, London, no. 28355.	58.
5.	*Cœlodus arcuatus*, sp. nov.; vomerine dentition, oral view, twice nat. size.—Ibid. Museum of Practical Geology, London, no. 28353.	70.



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1, 2. Eomesodon. 3, 4. Mesodon. 5. Cœlodus.

PLATE XIV.

FIG.		PAGE.
1.	*Microdon radiatus*, Agassiz; nearly complete fish, nat. size, with dorsal (1 *a*) and ventral (1 *b*) ridge-scale enlarged three times.—Middle Purbeck Beds; Swanage, Dorset. Dorset County Museum, Dorchester. *x.*, problematical bone at hinder end of abdominal region.	59.
2.	Ditto; imperfect fish with distorted tail, nat. size.—Ibid. Cunnington Collection (B. M. no. 46333). *c.*, displaced caudal fin-rays; *cl.*, clavicle; *dr.*, ventral ridge-scale with double articulation; *fr.*, frontal bone; *me.*, mesethmoid; *plv.*, pelvic fin; *vo.*, vomer.	59.
3.	Ditto; head and anterior abdominal region, nat. size.—Ibid. Dorset County Museum, Dorchester. *ag.*, angular; *d.*, dentary; *hm.*, displaced hyomandibular; *r.*, two expanded anterior ribs; *spl.*, splenial.	61.
4.	Ditto; left parietal bone (drawn upside down), showing hinder prominence (*x.*), twice nat. size.—Ibid. Egerton Collection (B. M. no. P. 1627 *a*).	60.
5.	Ditto; vomerine dentition, three times nat. size.—Ibid. Museum of Practical Geology, London, no. 28359.	62.
6.	Ditto; right dentary bone, five times nat. size.—Ibid. Museum of Practical Geology, London, no. 28352.	61.
7.	Ditto; splenials with dentition, oral view, with some lateral vomerine teeth to the left, three times nat. size.—Ibid. British Museum, no. P. 5592.	62.
8.	Ditto; right splenial dentition, oral view, three times nat. size.—Ibid. Egerton Collection (B. M. no. P. 1627 *a*).	62.
9.	Ditto; epihyal (*eph.*) and ceratohyal (*ch.*) bones, five times nat. size.—Ibid. Cunnington Collection (B. M. no. 28443).	62.
10.	Ditto; left hyomandibular (*hm.*), outer view, with remains of operculum (*op.*) partially overlapping the supraclavicle (*scl.*), twice nat. size.—Ibid. Egerton Collection (B. M. no P. 1627 *b*).	61.

G.M. Woodward del et lith. Huth imp

Microdon.

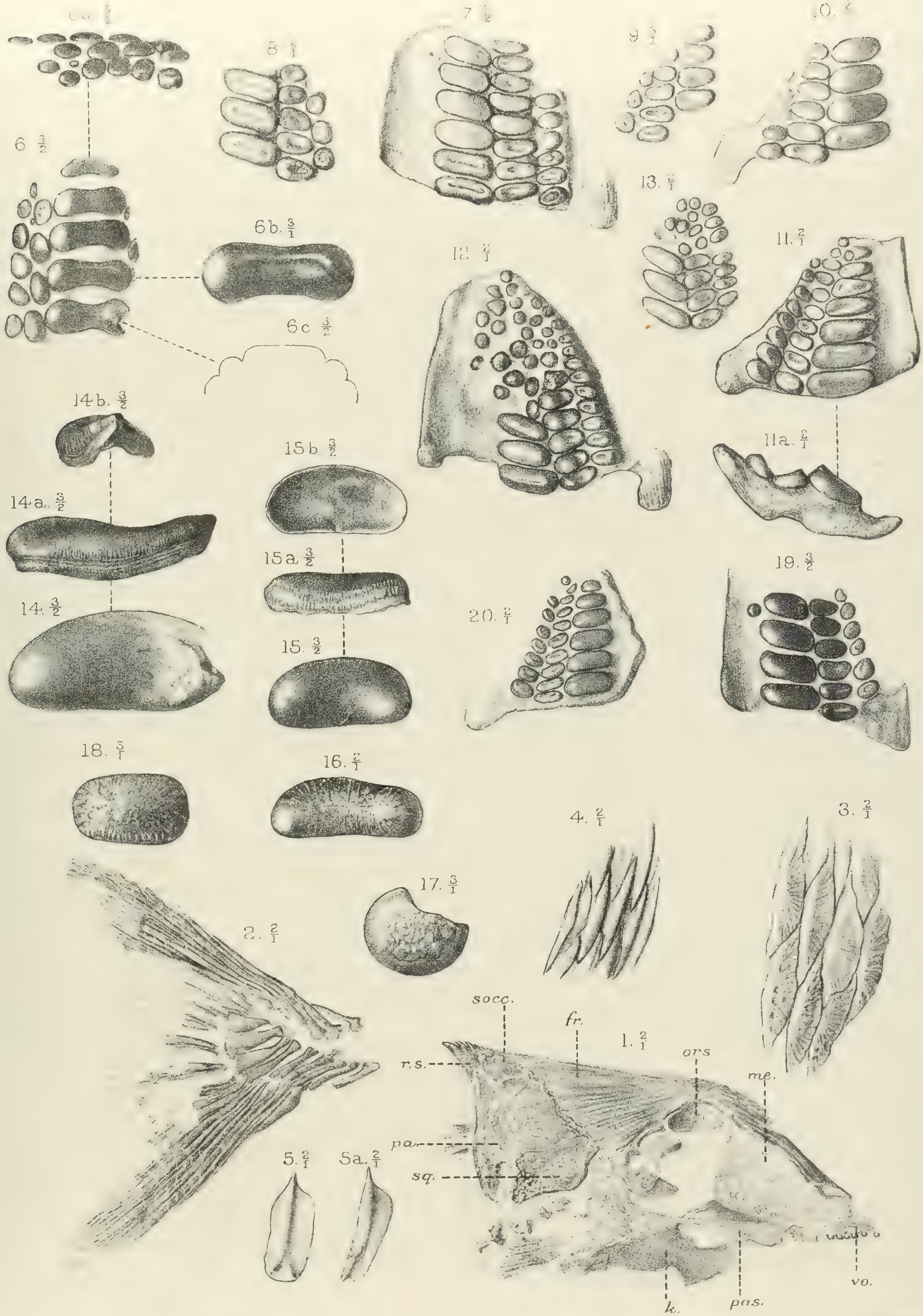
PLATE XV.

Fig. | Page.

1. *Microdon radiatus*, Agassiz; skull, right side view, twice nat. size.—Middle Purbeck Beds; Swanage, Dorset. British Museum, no. P. 7455. *fr.*, frontal; *k.*, lower median keel on parasphenoid; *me.*, mesethmoid; *ors.*, orbitosphenoid (?); *pa.*, parietal; *pas.*, parasphenoid; *r. s.*, ridge-scale fused with occiput; *socc.*, supraoccipital; *sq.*, squamosal; *vo.*, vomer. 59.
2. Ditto; caudal fin, twice nat. size.—Ibid. British Museum, no. 19013. 63.
3. Ditto; some abdominal flank-scales, left side, outer view, twice nat. size.—Ibid. Cunnington Collection (B. M. no. 46333). 64.
4. Ditto; some abdominal flank-scales, right side, inner view showing riblets, twice nat. size.—Ibid. British Museum, no. 44844. 64.

5, 5 *a*. Ditto; two abdominal flank-scales, right side, inner view, showing peg-and-socket articulation, twice nat. size.—Ibid. Dorset County Museum, Dorchester. 64.

6. *Cœlodus mantelli*, Agassiz; portion of vomerine dentition, oral view and right side view (6 *a*), three-halves nat. size, with a median tooth enlarged three times (6 *b*), and a transverse section of the dentition (6 *c*), three-halves nat. size.—Wealden; Tilgate Forest, Sussex. Mantell Collection (B. M. no. 28417). 66.
7. Ditto; right splenial, oral view, three-halves nat. size.—Wealden; Hastings, Sussex. Enniskillen Collection (B. M. no. P. 3763). 67.
8. Ditto; portion of right splenial dentition, oral view, twice nat. size.—Wealden; Tilgate Forest. Mantell Collection, no. 2709. 67.
9. Ditto; portion of left splenial dentition, oral view, three times nat. size.—Ibid. Type specimen of *Gyrodus mantelli*, Agassiz. Mantell Collection (B. M. no. 28415 *a*). 67.
10. Ditto; left splenial, oral view, twice nat. size.—Ibid. Mantell Collection (B. M. no. 28415 *b*). 67.
11. Ditto; left splenial, oral view, and hinder view (11 *a*), twice nat. size.—Lower Wealden or Upper Purbeck Beds; Netherfield, Sussex. Teilhard & Pelletier Collection (B. M. no. P. 11903). 67.
12. *Cœlodus multidens*, sp. nov.; right splenial, oral view, twice nat. size.—Wealden; Sevenoaks, Kent. The type specimen. Museum of Practical Geology, London, no. 7492. 68.
13. Ditto; portion of right splenial dentition, oral view, twice nat. size.—Wealden; Battle, Sussex. Bowerbank Collection (B. M. no. 39215). 68.
14. *Cœlodus hirudo* (Agassiz); a principal tooth of the left splenial dentition, oral view, front view (14 *a*), and end view (14 *b*), three-halves nat. size.—Wealden; Tilgate Forest, Sussex. The type specimen. Mantell Collection, no. 2706. 68.
15. Ditto; a principal tooth probably of the vomerine dentition, oral view, hinder view (15 *a*), and lower view (15 *b*), three-halves nat. size.—Wealden; Hastings, Sussex. Rufford Collection (B. M. no. P. 9838). 68.
16. Ditto; a principal tooth, oral view, twice nat. size.—Wealden (Wadhurst Clay); Hastings. Teilhard & Pelletier Collection (B. M. no. P. 11900). 69.
17. Ditto; an imperfect lateral tooth, three times nat. size.—Ibid. Teilhard & Pelletier Collection (B. M. no. P. 11901). 69.
18. Ditto; lateral tooth, five times nat. size.—Ibid. Teilhard & Pelletier Collection (B. M. no. P. 11902). 69.
19. *Cœlodus lævidens*, sp. nov.; right splenial, oral view, three-halves nat. size.—Middle Purbeck Beds; Swanage, Dorset. The type specimen. British Museum, no. P. 10679. 69.
20. Ditto; left splenial, oral view, twice nat. size.—Ibid. British Museum, no. 33480. 69.

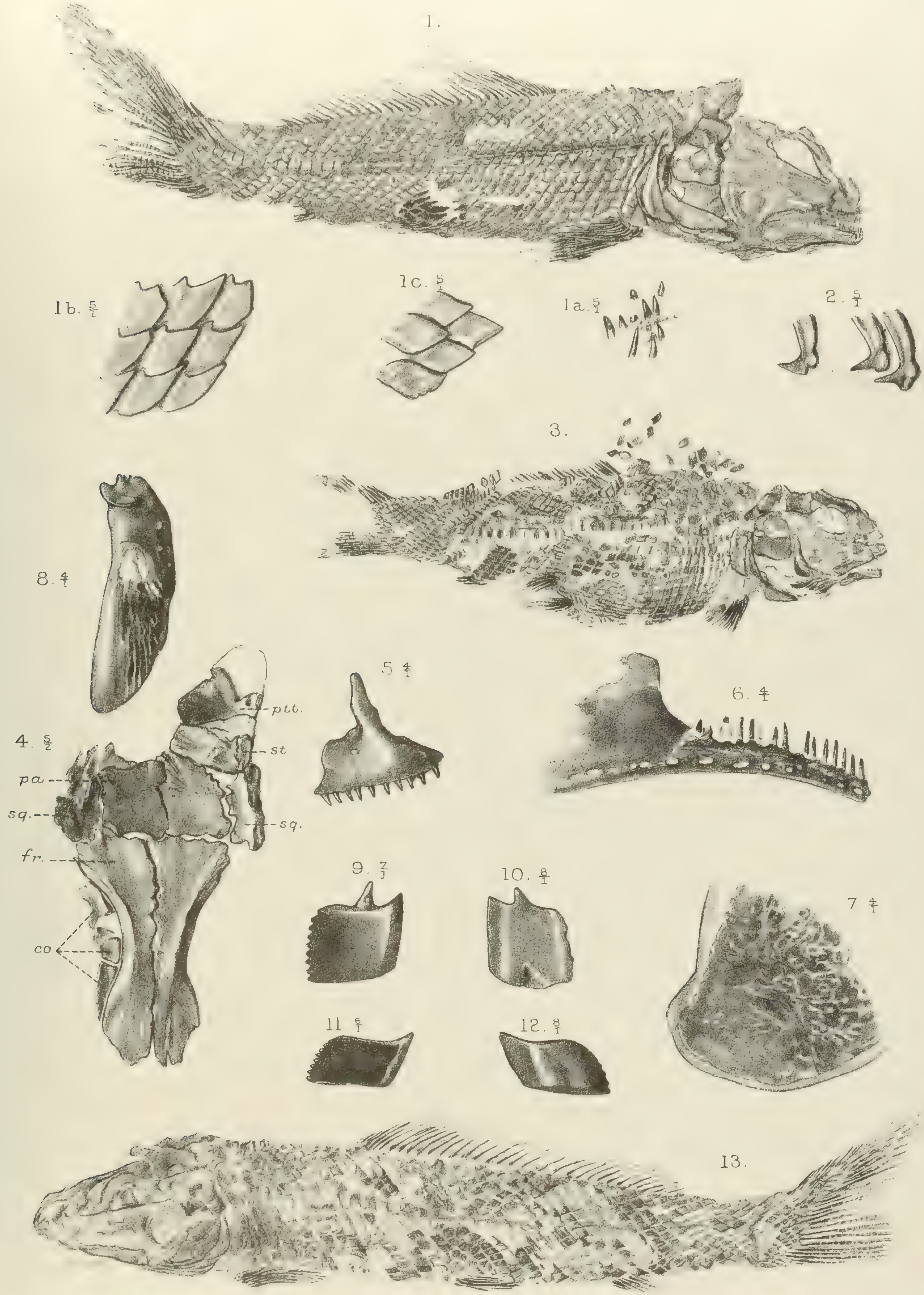


G.M. Woodward del.et lith. Huth imp.

1-5. Microdon. 6-20. Cœlodus.

PLATE XVI.

Fig.		Page.
1.	*Ophiopsis penicillata*, Agassiz; nearly complete fish, showing most of squamation from inner face, nat. size, with a group of teeth (1 *a*), some abdominal flank-scales, inner view (1 *b*), and some caudal scales, outer view (1 *c*), enlarged five times.—Probably from Lower Purbeck Beds near Weymouth, Dorset. The type specimen. British Museum, no. P. 7433.	72.
2.	Ditto; bases of some dorsal fin-rays, five times nat. size.—Lower Purbeck Beds; Isle of Portland. British Museum, no. P. 8375.	73.
3.	*Ophiopsis breviceps*, Egerton; nearly complete fish, nat. size.—Lower Purbeck Beds; Wockley, near Tisbury, Wiltshire. The type specimen. Museum of Practical Geology, London, no. 28442.	74.
4.	Ditto; roof of skull and some adjacent bones, inner view, five-halves nat. size.—Ibid. British Museum, no. P. 9107 *a*. *co.*, upper circum-orbitals; *fr.*, frontal; *pa.*, parietal; *ptt.*, post-temporal; *sq.*, squamosal; *st.*, supratemporal.	74.
5.	Ditto; right premaxilla, outer view, four times nat. size.—Ibid. British Museum, no. P. 9436.	74.
6.	Ditto; right mandibular ramus, outer view, four times nat. size.—Ibid. British Museum, no. P. 9436.	74.
7.	Ditto; portion of operculum to show ornament, four times nat. size.—Ibid. Enniskillen Collection (B. M. no. P. 3608).	74.
8.	Ditto; left supraclavicle, outer view, four times nat. size.—Ibid. British Museum, no. P. 9436.	75.
9, 10.	Ditto; flank-scales, outer and inner face, seven and eight times nat. size.—Ibid. British Museum, nos. P. 9107 *b*, *c*.	75.
11.	Ditto; ventral scale, outer face, six times nat. size.—Ibid. British Museum, no. P. 9436.	75.
12.	Ditto; dorsal scale, inner face, eight times nat. size.—Ibid. British Museum, no. P. 9107 *b*.	75.
13.	*Ophiopsis dorsalis*, Agassiz; nearly complete fish, nat. size.—Probably from Middle Purbeck Beds, Swanage, Dorset. The type specimen. Egerton Collection (B. M. no. P. 466).	76.



G. M Woodward del. et lith. Huth imp

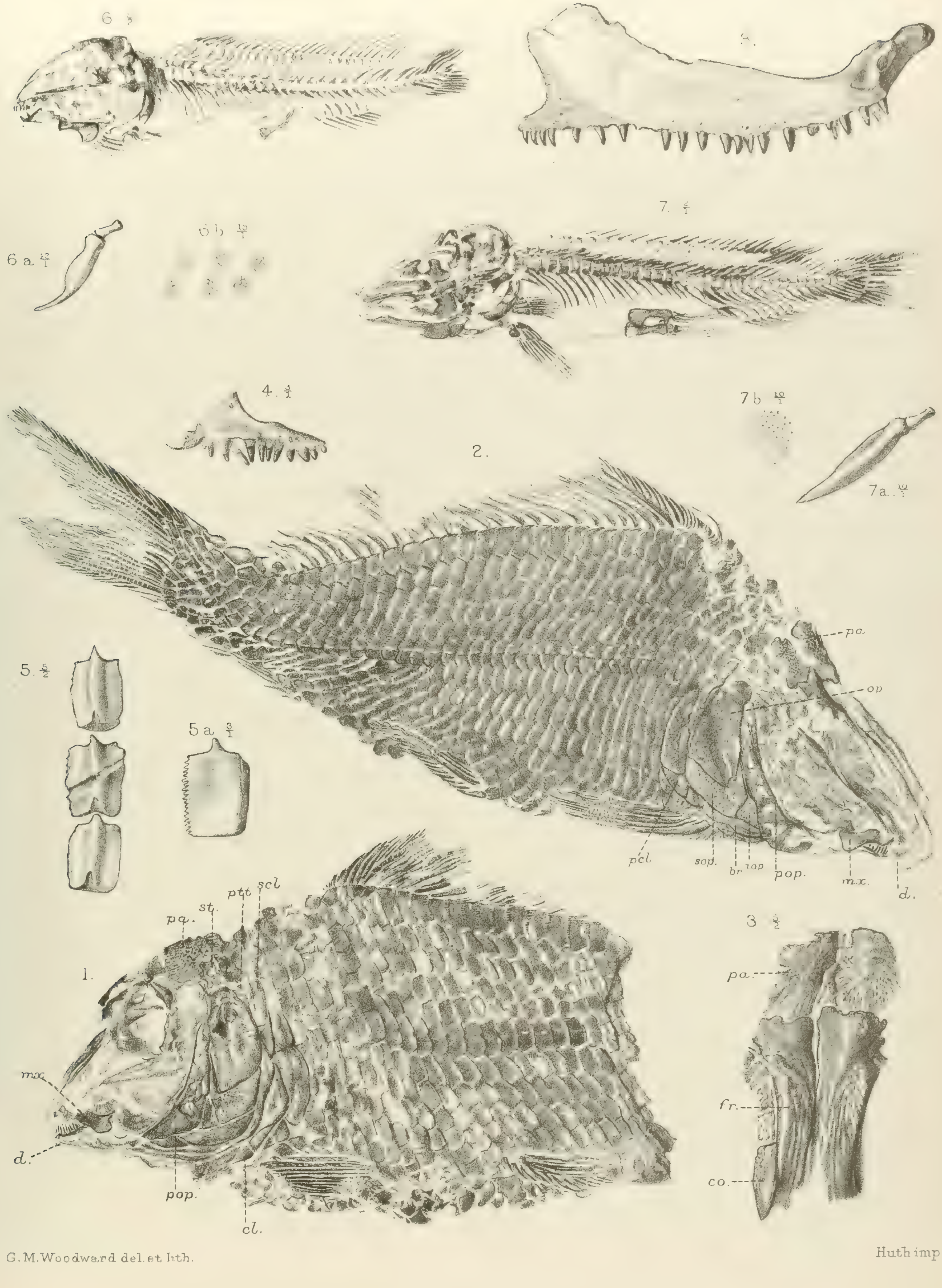
Ophiopsis.

PLATE XVII.

Fig.		Page.
1.	*Histionotus angularis*, Egerton; fish with imperfect dorsal fin, lacking greater part of caudal region, nat. size.—Middle Purbeck Beds; Swanage. The type specimen. Egerton Collection (B. M. no. P. 577). *cl.*, clavicle; *d.*, dentary; *mx.*, maxilla; *pa.*, parietal; *pop.*, pre-operculum; *ptt.*, post-temporal; *scl.*, supraclavicle; *st.*, supra-temporal.	77.
2.	Ditto; nearly complete fish, with crushed cranium and distorted tail, nat. size.—Ibid. Dorset County Museum, Dorchester. *br.*, branchi-ostegal rays; *d.*, dentary; *iop.*, interoperculum; *mx.*, maxilla; *op.*, operculum; *pa.*, parietal; *pcl.*, post-clavicular scales; *pop.*, preoper-culum; *sop.*, suboperculum.	77.
3.	Ditto; roof of skull, two-and-a-half times nat. size.—Ibid. British Museum, no. P. 5935. *co.*, upper circumorbitals; *fr.*, frontal; *pa.*, parietal.	77.
4.	Ditto. Supposed palatine or ectopterygoid, with comparatively stout teeth, three times nat. size.—Middle Purbeck Beds; Tisbury, Wilt-shire. Cunnington Collection (B. M. no. 46421).	78.
5.	Ditto; inner view of three flank-scales, one traversed by the slime-canal of the lateral line (*l.*), two-and-a-half times nat. size, and (5 *a*) a flank-scale, outer face, three times nat. size.—Middle Purbeck Beds; Swanage. Enniskillen Collection (B. M. no. P. 3614).	79.
6.	*Enchelyolepis andrewsi*, A. S. Woodward; nearly complete fish, two-and-a-half times nat. size, with a dorsal fin-support (6 *a*) enlarged twelve times, and some scales (6 *b*) enlarged fifteen times.—Middle Pur-beck Beds; Teffont, Wiltshire. The type specimen. Rev. W. R. Andrews Collection (B. M. no. P. 6303).	81.
7.	*Enchelyolepis pectoralis* (Sauvage); nearly complete fish, twice nat. size, with a dorsal fin-support (7 *a*) and a scale (7 *b*) enlarged ten times.—Upper Portlandian; Savonnières-en-Perthois, Meuse, France. The type specimen. British Museum, no. P. 7359.	81
8.	*Œonoscopus* sp.; right maxilla, outer view, nat. size.—Middle Purbeck Beds; Swanage. British Museum, no. 33477.	

A. S. Woodward, Wealden & Purbeck Fishes

Plate XVII



G. M. Woodward del. et lith.

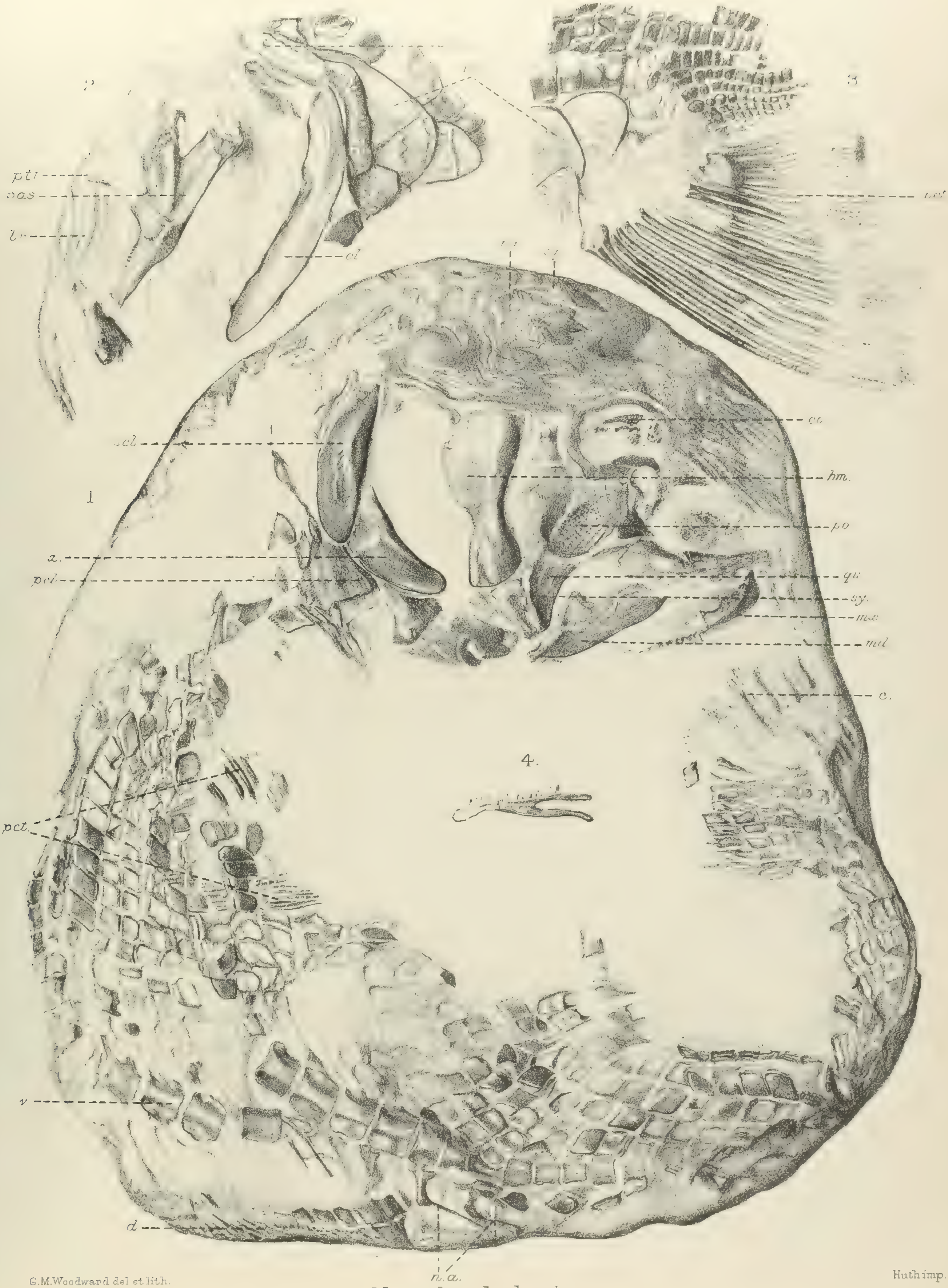
Huth imp.

1–5. Histionotus 6, 7 Enchelyolepis. 8. Oeonoscopus.

PLATE XVIII.

Fig.		Page
1.	*Neorhombolepis valdensis*, A. S. Woodward; imperfect fish coiled up in ironstone, nat. size.—Wealden; Hastings. The type specimen. Beckles Collection (B. M. no. P. 6364).	88.
2, 3.	Ditto; portions of head, pectoral arch, pectoral fin, and anterior scales of opposite side of same specimen, nat. size.	88.
4.	Ditto; remains of dentary bone of same specimen, nat. size.	88.

br., branchiostegal rays; *c.*, remains of caudal fin; *cl.*, clavicle; *co.*, circum-orbital; *d.*, base of dorsal fin; *hm*, hyomandibular; *md.*, hinder end of mandible; *mx.*, portion of maxilla; *n.a.*, neural arches of vertebræ; *pa.*, parietal; *pas.*, para-sphenoid; *pcl.*, postclavicular plates; *pct.*, pectoral fin; *po.*, portion of postorbital; *ptf.*, postfrontal (sphenotic); *qu.*, quadrate; *scl.*, supraclavicle; *sq.*, squamosal; *sy.*, symplectic; *v.*, vertebral centrum; *x.*, interoperculum (?)



G.M.Woodward del et lith. Huth imp.

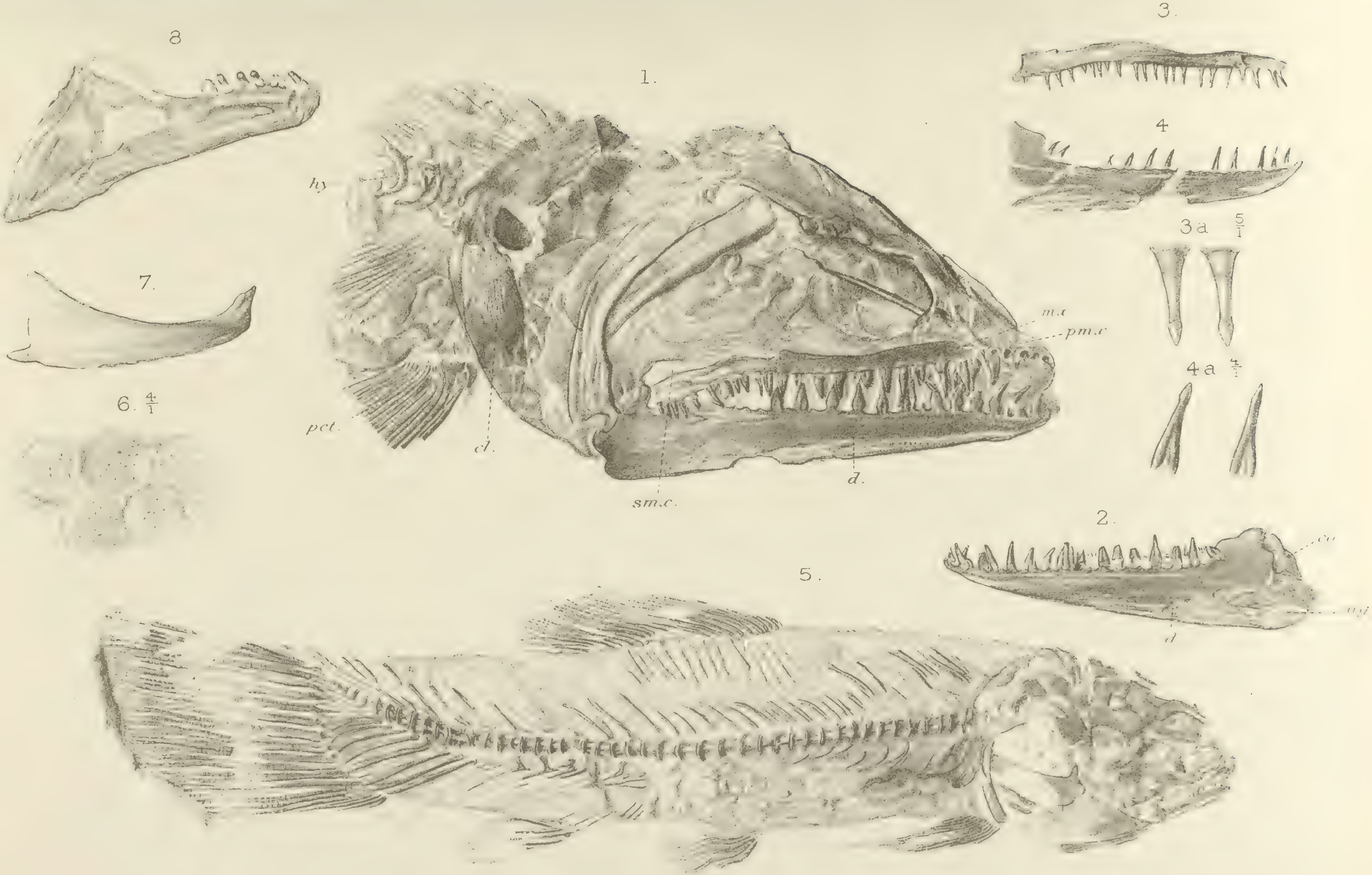
Neorhombolepis.

PLATE XIX.

Fig.		Page.
1.	*Caturus purbeckensis*, A. S. Woodward; head, etc., crushed in right side view, nat. size.—Middle Purbeck Beds; Swanage. The type specimen. British Museum, no. 46911. *cl.*, clavicle; *d.*, dentary; *hy.*, hypocentrum; *mx.*, maxilla; *pct.*, base of pectoral fin; *pmx.*, premaxilla; *smx.*, supramaxilla.	85.
2.	Ditto; left mandibular ramus, outer view, nat. size.—Ibid. Sedgwick Museum, Cambridge. *ag.*, angular; *co.*, coronoid; *d.*, dentary.	86.
3.	*Caturus tenuidens*, A. S. Woodward; left maxilla, inner view, nat. size, with two teeth enlarged five times (3 *a*).—Ibid. Egerton Collection (B. M. no. P. 969).	87.
4.	Ditto; right dentary, outer view, nat. size, with two teeth enlarged four times (4 *a*).—Ibid. British Museum, no. 40656.	87.
5.	*Amiopsis damoni* (Egerton); nearly complete fish, right side view, nat. size.—Purbeck Beds; Portland. British Museum, no. 41156.	91.
6.	Ditto; some abdominal flank-scales of type specimen, four times nat. size.—Purbeck Beds; Bincombe, near Weymouth. Egerton Collection (B. M. no. P. 563.)	92.
7.	*Amiopsis* sp.; right maxilla, without teeth, outer view, nat. size.—Lower Purbeck Beds; Portland. British Museum, no. P. 8376.	94.
8.	*Amiopsis* sp.; left mandibular ramus, inner view, nat. size, with points of teeth broken away.—Ibid. British Museum, no. P. 8377.	94.

A. S. Woodward, Wealden & Purbeck Fishes.

Plate XIX.



G. M. Woodward, del et lith.

Huth, imp.

1 – 4. Caturus. 5 – 8 Amiopsis.

PLATE XX.

FIG. PAGE.

1. *Aspidorhynchus fisheri*, Egerton; almost complete fish, right side view, nearly two-thirds nat. size, with remains of branchial arches (1 *a*) and some dorsal caudal scales (1 *b*) enlarged three times.—Middle Purbeck Beds; Swanage. The type specimen. Dorset County Museum, Dorchester. *a.*, anal fin; *d.*, dorsal fin; *plv.*, pelvic fins. 97.
2. Ditto; head, etc., left side view and partly upper view, three-halves nat. size.—Ibid. British Museum, no. 28621. *ag.*, angular; *cl.*, clavicle; *d.*, dentary; *fr.*, frontal; *hm.*, hyomandibular; *mx.*, maxilla; *op.*, operculum; *pa.*, parietal; *pas.*, parasphenoid; *pct.*, pectoral fin; *pmx.*, premaxilla; *ps.*, presymphysial bone; *qu.*, quadrate; *smx.*, supramaxilla; *sy.*, symplectic; *x.*, probably epiotics. 97.
3. Ditto; portion of abdominal squamation, nat. size, with (3 *a*) three ventral scales five-halves nat. size.—Ibid. Museum of Practical Geology, London, no. 28440. 99.
4. Ditto; dorsal caudal scales, three times nat. size.—Ibid. Beckles Collection (B. M. no. P. 6380). 99.
5. *Pholidophorus ornatus*, Agassiz; imperfect tail, nat. size, with scale (5 *a*) enlarged twice.—Ibid. The type specimen. Mantell Collection (B. M. no. P. 7583). *a.*, anal fin; *plv.*, pelvic fin; *v.*, vertebral centrum. 102.
6. Ditto; small fish, left side view, nat. size, with (6 *a*) jaws enlarged twice, and (6 *b*) abdominal flank-scales enlarged three times.—Ibid. Alexander J. Hogg Collection (B. M. no. P. 10011). *ag.*, angular; *d.*, dentary; *mx.*, maxilla; *pmx.*, premaxilla; *smx.*, supramaxilla. 102.
7. Ditto; caudal scales of lateral line, outer view, five-halves nat. size, and abdominal ventral scales (7 *a*) of same specimen, inner view, three times nat. size.—Ibid. British Museum, no. 43038. 105.
8. Ditto; abdominal ventral scales, outer view, three times nat. size.—Ibid. Museum of Practical Geology, London, no. 28439. 105.

G.M.Woodward, del et lith. Huth. imp

1 4 Aspidorhynchus 5 8 Pholidophorus

Palæontographical Society, 1916.

THE

PLIOCENE MOLLUSCA

OF

GREAT BRITAIN,

BEING SUPPLEMENTARY TO

S. V. WOOD'S MONOGRAPH OF THE CRAG MOLLUSCA.

BY

F. W. HARMER, F.G.S., F.R.Met.S.,

MEMBRE HONORAIRE DE LA SOCIÉTÉ BELGE DE GÉOLOGIE ET DE PALÉONTOLOGIE.

PART III.

Pages 303—461; Plates XXXIII—XLIV.

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February, 1918.

PRINTED BY ADLARD AND SON AND WEST NEWMAN, LTD., LONDON AND DORKING.

Since the publication of Parts I and II of this volume some interesting specimens of the genera therein dealt with have come into my possession, especially from the Wexford gravels, which, through the energy of my old colleague Mr. Alfred Bell and with the kind assistance of the Rev. Father Codd, P.P., of Blackwater, near Enniscorthy, have been lately obtained.

Those I have already received from that locality have proved very interesting, but as the sections from which they come are said to be some miles in length and in places to be full of shelly material, they may prove still more so as time goes on.

My first idea was to reserve such new material for a possible Appendix at the conclusion of the work, but as for an obvious reason this may never be reached, it seems better to describe from year to year such specimens as may reach me, even if some of them may be more or less out of place. It will give me the opportunity, moreover, of discussing the important fauna of St. Erth as well as some fossils from the Pleistocene deposits of Great Britain which are closely related to those of the Pliocene, and should be considered with them.

As to some divisions of the Crag Mollusca which I have not yet touched, I fear I may not be able to deal with them as fully as I could wish, and that I shall have to leave much to my successors. For the present I must content myself with endeavouring to bring up to date, as far as I can, the nomenclature, identification and distribution of certain groups, for the study of which I may have most material at my disposal, or which may seem likely to be of most interest to students of the later Tertiary fauna.

Genus **HELIX**, Linné, 1758 (*continued from p.* 17).

Sub-genus **MACULARIA**, Albers, 1850.

Helix (Macularia) Ogdeni, Kennard and B. B. Woodward. Plate XXXIII, fig. 1.

1914. *Helix* (*Macularia*) *Ogdeni*, Kennard and B. B. Woodward, Proc. Malac. Soc., vol. xi, p. 155 (figs.).

Specific Characters.—Shell imperforate, depressed, conic, showing traces of oblique lines of growth; whorls five, convex, regularly increasing; apex obtuse; suture linear, moderately impressed; body-whorl about half the size of the shell, scarcely dilated, convex below and impressed in the umbilical region, deeply

deflexed anteriorly; aperture broadly lunate, margins distant; outer lip narrowly expanded, having a slight thickening within; columella margin deflected, with a reflected callus concealing the umbilicus. (K. and B.B.W.)

Dimensions.—Diam. (max.) 16·4 mm. H. 10·8 mm. Mouth 6–7 × 8·8 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Ramsholt.

Remarks.—The specimen now figured was found by Mr. Ogden, jun., in the Crag at Ramsholt, exposed in a low cliff on the banks of the River Deben. It has been determined as new, and very appropriately named after the discoverer by Messrs. Kennard and B. B. Woodward. They state that they have failed to identify it with any Continental species, either living or fossil, its nearest living ally being the southern shell *Helix* (*Macularia*) *Oberndoerferi*, Kobelt. I trust they will pardon my suggesting the possibility of the bed at Ramsholt from which this fossil was obtained being of Coralline rather than of Red Crag age, as they suggest.

H. and A. Adams state that all the known species of *Macularia* are from the south of Europe.

Genus CYPRÆA, Linné, 1758.

Sub-genus EROSARIA, Troschel, 1863.

Cypræa (Erosaria) spurca (Linné) (?). Plate XXXIII, figs. 7, 8.

1758. *Cypræa spurca*, Linné, Syst. Nat., ed. x, p. 724, no. 317.
1836–44. *Cypræa spurca*, Philippi, Enum. Moll. Sic., vol. i, p. 235, 1836; vol. ii, p. 199, 1844.
1837. *Cypræa spurca*, Sowerby, Conch. Illustr., fig. 81.
1845. *Cypræa spurca*, Reeve, Conch. Icon., vol. iii (Cypræa), pl. xiv, fig. 68.
1846. *Cypræa sp*, James, Journ. Geol. Soc. Dublin, vol. iii, p. 196.
1846. *Cypræa sp.*, Forbes, Mem. Geol. Surv., vol. i, p. 429.
1865. *Cypræa lurida*, Huxley and Etheridge, Cat. Coll. Foss. Mus. Pract. Geol., p. 375.
1870. *Cypræa spurca*, Hidalgo, Moll. mar. Espan., vol. ii (Cypræa), p. 8, pl. xi, figs. 1, 2.
1888–90. *Cypræa sp.*, A. Bell, Rep. Brit. Assoc. (Bath), p. 136, 1888; (Leeds), p. 423, 1890.
1890. *Cypræa spurca*, Carus, Prod. Faun. Medit., vol. ii, p. 370.
1891. *Cypræa* (*Erosaria*) *spurca*, Dautzenberg, Mém. Soc. zool. France, vol. iv, p. 23.
1892–7. *Cypræa spurca*, Locard, Coq. mar. Côtes de France, p. 38, 1892; Exped. scient. Travailleur et Talisman, vol. i, p. 102, 1897.
1893. *Cypræa spurca*, Dall, Proc. U.S. Nat. Mus., vol. xvi, p. 332.
1908. *Cypræa* (*Erosaria*) *spurca*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iv, p. 49, pl. cix, figs. 1–11.
1911. *Cypræa* (*Erosaria*) *spurca*, Cerulli-Irelli, Palaeont. Ital., vol. xvii, p. 271, pl. xxvi, fig. 13.
1915. *Cypræa pyrum*, A. Bell, Geol. Mag. [6], vol. ii, p. 168.

Specific Characters.—Shell oblongo-ovate, convex, but little depressed at the spire, which is very small and covered; sides and extremities of the shell

thickened, marginate; aperture expanded below, outer lip nearly straight; teeth prominent, coarser and less numerous than in *C. pyrum* or *C. lurida.*

Dimensions.—L. 30–34 mm. B. 18–20 mm. (of fossil specimen: L. 17 mm. B. 11 mm.).

Distribution.—Recent: western coast of Spain, Cape Verde Isles, Canaries, Ascension, St. Helena, Morocco. Mediterranean—Balearic Isles, Corsica, Naples, Sicily, Algeria, Tunis, Tripoli, Egypt, Ægean, Syrian coast. West Indies, Florida, Pernambuco.

Fossil: Kilbride, co. Wicklow. Monte Mario, Cyprus, Palermo.

Remarks.—The history of this unique fossil is rather interesting. Originally discovered by Captain (afterwards Sir Henry) James, it was described in 1846 by him and by Edward Forbes as *Cypræa sp.* For many years it has remained in the Jermyn Street collection without any definite specific name. In 1865 it was referred by Messrs. Huxley and Etheridge to the Mediterranean form *C. lurida*, Linné, and afterwards by Alfred Bell to *C. pyrum*, Gmelin. Hesitating which of these competent authorities to follow, I wrote to my good friend the Marchese di Monterosato, who has so often and so willingly rendered me similar assistance, asking him to send me some typical specimens of both these species for comparison, which he was kind enough to do; but he enclosed with them an example of *C. spurca*, and it was the latter species with which our fossil seemed most nearly to correspond. The two shells are not absolutely the same, however, and my identification may possibly need reconsideration.

C. spurca seems to be specially characterised by its form and the prominent and rather coarse sculpture of both sides of the aperture. It has been reported as a fossil from Monte Mario by Sign. Cerulli-Irelli, from Cyprus by Gaudry, and as sub-fossil from Palermo by Philippi, but not, so far as I know, from any other locality, either British or foreign, although it now occurs living in all parts of the Mediterranean.

Forbes, indeed, suggested that the Wicklow specimen was a recent one, as it had a very fresh appearance. It was said to have been found, however, in a marine deposit, and many of the fossils from the same region are of a similarly fresh and unworn character. He considered it desirable, moreover, to include it in his list of Irish fossils, and as it still appears exhibited among them in the Jermyn Street galleries I follow his example. In any case it suggests the existence of marine currents from the south at a certain stage or stages of the geological history, to which also the existence of so many Lusitanian species in the Pleistocene deposits of the Christiania fiord before alluded to may also have been due.

Genus **COLUMBELLA**, Lamarck, 1799.

Sub-genus **MITRELLA**, Risso, 1826.

Columbella (Mitrella) erythrostoma (Bonelli). Plate XXXIII, figs. 11, 12.

1825. *Columbella erythrostoma*, Bonelli, MS. Cat. Mus. Zool. Torino.
1848. *Columbella erythrostoma*, Bellardi, Mon. Columb., p. 9, pl. i, figs. 4, 5.
1870. *Columbella erythrostoma*, A. Bell, Journ. de Conch., vol. xviii, p. 347, no. 234.
1875. *Columbella erythrostoma*, Seguenza, Boll. R. Com. Geol. Ital., vol. vi, p. 276, no. 245.
1882. *Columbella erythrostoma*, S. V. Wood, Mon. Crag Moll., 3rd Suppl., p. 6, pl. i, fig. 10b.
1890. *Columbella erythrostoma*, C. Reid, Plioc. Dep. Brit., p. 242.
1890–1904. *Columbella* (*Mitrella*) *erythrostoma* and vars., Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 223, nos. 2874–76, 1890; Moll. Terr. Terz. Piem., pt. vi, p. 40, pl. ii, fig. 40, 1890; pt. xxx, p. 93, pl. xix, figs. 51–54, 1904.
1901. *Mitrella erythrostoma*, Cossmann, Ess. Paléoconch. compar., vol. iv, p. 236.
1911. *Columbella* (*Mitrella*) *erythrostoma*, Cerulli-Irelli, Palaeont. Ital., vol. xvii, p. 256, pl. xxiii, figs. 64, 65.

Specific Characters.—Shell slender, with a comparatively narrow base; whorls but little convex, smooth, without spiral sculpture except near the base, the last rather more than half the total length; spire elevated, diminishing regularly upwards; suture slight; mouth narrow; outer lip compressed and nearly straight in the middle, rounded below, denticulated within; canal very short.

Dimensions.—L. 20–30 mm. B. 8–12 mm.

Distribution.—Not known living.

Fossil: Waltonian Crag: Walton-on-Naze, Little Oakley. Newbournian: Newbourn. Lower Pliocene: Biot. Upper Pliocene: Asti, Livorno, Monte Mario.

Remarks.—This species resembles very nearly the Crag form, *C. sulcata*, described below, but the whorls are not so concave, the suture is slighter, the shape more slender, and except for a few fine inconspicuous ridges at the back of the canal, it is without spiral sculpture. It is possible that in some cases worn and decorticated specimens of *C. sulcata* may have been mistaken for it. As a guide to collectors, however, I have figured a verified fossil from Asti, which I have received from my good friend Prof. Issel of Genoa, to whom I have been indebted on more than one occasion for similar assistance. I give also an example from Walton which seems to be the same, and I have one or two others, similar, but imperfect, from Oakley.

The genus *Columbella*, under which name the Crag forms of the Columbellidæ were formerly grouped, has been divided and sub-divided since the publication of Wood's Monograph, the generic and sub-generic terms here used being mostly those adopted by M. Cossmann.

Columbella (Mitrella) semicaudata (Bonelli). Plate XXXIII, figs. 9, 10.

1825. *Columbella semicaudata*, Bonelli, MS. Cat. Mus. Zool. Torino.
1848. *Columbella semicaudata*, Bellardi, Mon. Columb., p. 8, pl. i, fig. 3.
1870. *Columbella semicaudata*, A. Bell, Journ. de Conch., vol. xviii, p. 346.
1875. *Columbella semicaudata*, Seguenza, Boll. R. Com. Geol. Ital., vol. vi, p. 276, no. 238.
1878. *Columbella semicaudata*, de Stefani e Pantinelli, Bull. Soc. Malac. Ital., vol. iv., p. 109.
1890. *Columbella (Mitrella) semicaudata*, Sacco, Moll. Terr. Terz. Piem., pt. vi, p. 40, pl. ii, fig. 39; Boll. Soc. Geol. Ital., vol. ix, p. 223, no. 2883.
1901. *Mitrella semicaudata*, Cossmann, Ess. Paléoconch. compar., vol. iv., p. 236.
1911. *Columbella (Mitrella) semicaudata*, Cerulli-Irelli, Palaeont. Ital., vol. xvii, p. 255, pl. xxiii, figs. 60–63.

Specific Characters.—Shell slender with a comparatively narrow base, smaller than *M. erythrostoma*; whorls nearly flat, smooth, without spiral sculpture, the last more than half the total length; spire elevated, diminishing slightly but regularly upwards; suture slight; mouth narrow; outer lip compressed in the middle and nearly straight, rounded below, denticulated within; canal very short.

Dimensions.—L. 20 mm. B. 8 mm.

Distribution.—Not known living.

Fossil: Waltonian Crag: Little Oakley. Lower Pliocene: Biot. Upper Pliocene: Bologna, Asti, Siena, Monte Mario, Val d'Era.

Remarks.—The imperfect fossil from Oakley here figured appears to correspond, so far as it goes, with some specimens of *C. semicaudata* which I collected some years ago at Asti, as well as with one recently received from Prof. Issel from the same locality. It shows no sign of the spiral sculpture characteristic of *C. sulcata* and presents a polished surface, a feature which I have never observed in the case of water-worn examples of the latter species in my Crag collections.

Columbella (Mitrella) sulcata (J. Sowerby). Plate XXXIII, figs. 13—17.

1823–5. *Buccinum sulcatum*, J. Sowerby, Min. Conch., vol. iv, p. 103, pl. ccclxxv, fig. 2, 1823; vol. v, p. 122, pl. cccclxxvii, fig. 4, 1825.
1842–72. *Columbella sulcata*, vars. α and β, S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix, p. 539, 1842; Mon. Crag Moll., pt. i, p. 23, pl. ii, fig. 2, 1848; 1st Suppl., pt. i, p. 9, pl. ii, fig. 16, 1872.
1870. *Columbella sulcata*, S. V. Wood, jun., and F. W. Harmer, Rep. Sections Brit. Assoc. (Liverpool), p. 91.
1871. *Columbella sulcata*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, pp. 143, 488.
1871. *Columbella sulcata* and *C. abbreviata*, A. Bell, Ann. Mag. Nat. Hist. [4], vol. vii, p. 356; Geol. Mag., vol. viii, p. 453.
1872. *Columbella sulcata* and *C. abbreviata*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 203, 209, 213.
1892. *Columbella sulcata*, Van den Broeck, Bull. Soc. Belg. Géol., vol. vi (Mémoires), pp. 121, 132.
1901. *Anachis sulcata*, Cossmann, Ess. Paléoconch. compar., vol. iv, p. 238.
1912. *Columbella sulcata*, Tesch, Med. v. d. Rijks. v. Delfstoffen, pt. iv, p. 78, no. 188.

Specific Characters.—Shell turreted, elongate; whorls 6—8, convex, regularly diminishing in size to a blunt and rounded apex; ornamented by fine, closely-set spiral ridges which extend to the base of the shell; spire elevated, varying much in its comparative length; suture well-marked but generally not very deep; mouth long, sub-trapezoidal, angulate above; outer lip compressed in the middle, nearly straight, thickened and toothed internally; canal wide, open, very short, turning to the left; columella flexuous, excavated.

Dimensions.—(Very variable) L. 15—30 mm. B. 8—12 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Gedgrave, Sutton, Boyton. Waltonian: Walton-on-Naze, Beaumont, Little Oakley. Newbournian: Waldringfield, Ramsholt, Felixstow, Sutton, Bentley. Butleyan: Butley, Hollesley.

Middle Glacial sands: Billockby.

Scaldisien: Belgium, Dutch borings.

Remarks.—The present species, so far as I know, has been recorded as fossil from the Anglo-Belgian region only, and is apparently an extinct form. It is one of the common and characteristic species of the Waltonian deposits, but it is not so abundant either in the Coralline or the later horizons of the Red Crag. It varies considerably, especially in the length of the spire. Sowerby figured two forms, Wood's varieties α and β; the first (var. *elongata*) a slender shell with an elongated spire, convex whorls, and a deep suture; the other with a shorter spire and flatter whorls. For the latter Mr. A. Bell proposed in 1871 (*op. cit.*) the specific name *abbreviata*, remarking that "the long and short varieties are constant and easily distinguishable, even in immature specimens." My experience with the Oakley fossils is somewhat similar, but the short-spired shells found at that locality are not all abbreviated, ranging in length from 15 to 30 mm. or more.

The Crag *C.* (*Mitrella*) *sulcata* is allied to the *C.* (*Mitrella*) *erythrostoma* of the Italian Pliocene, but it is always spirally striated, the whorls are more convex, and the suture is deeper. Specimens of the Crag shell which have lost their outer coating have sometimes been mistaken for the Italian species.

Columbella (Mitrella) sulculata (S. V. Wood). Plate XXXIII, figs. 18, 19.

1879. *Columbella* (*Astyris*) *sulculata*, S. V. Wood, Mon. Crag Moll., 2nd Suppl., p. 4, pl. i, fig. 3.
1890. *Columbella sulculata*, C. Reid, Plioc. Dep. Brit., p. 243.
1901. *Anachis sulculata*, Cossmann, Ess. Paléoconch. compar., vol. iv, p. 238.
1915. *Columbella sulculata*, A. Bell, Geol. Mag. [6], vol. ii, p. 167.

Specific Characters.—Shell solid, slender, turreted, elongate, smaller than the last species; whorls 6 or 7, but slightly convex, regularly diminishing in size to a blunt point; spire elevated, of variable length; suture well marked but not deep; ornamented with clearly-cut and closely-set spiral ridges which reach to the base

of the shell; mouth short, oval; outer lip grooved internally; canal distinct, very short.

Dimensions.—L. 12—18 mm. B. 6—8 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Boyton. Waltonian: Walton-on-Naze, Beaumont, Little Oakley. Newbournian: Bentley, Waldringfield, Sutton. Butleyan: Butley, Shottisham. Isle of Man.

Remarks.—This shell is very abundant at Oakley where I have obtained nearly 100 specimens of it; except that it has been recently found in the Manxland drift, it has not been reported from any other formation than the English Crag. It is easily distinguished from the last species by its slender form, its smaller size, its more solid character, its more distinct sculpture and the shape of its mouth and its canal. Nyst identified it with *C. sulcata*, but this view I am unable to accept.[1]

Sub-genus **COLUMBELLOPSIS**, Bucq., Dautz. et Dollf., 1882.

Columbella (Columbellopsis) Borsoni (Bellardi). Plate XXXIII, figs. 20, 21.

1848. *Columbella Borsoni,* Bellardi, Mon. Columb., p. 14, pl. i, fig. 11.

1872. *Columbella Borsoni,* A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 209, 213.

1874. *Columbella Borsoni,* S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. ii, p. 174, add. pl., fig. 19.

1890–1904. *Columbella (Clinurella) Borsoni,* Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 224, no. 2897, 1890; Moll. Terr. Terz. Piem., pt. vi, p. 45, pl. ii, fig. 52, 1890; *C. (Atilia) Borsoni,* pt. xxx, p. 94, 1904.

1890. *Columbella Borsoni,* C. Reid, Plioc. Dep. Brit., p. 242.

1901. *Atilia Borsoni,* Cossmann, Ess. Paléoconch. compar., vol. iv, p. 243.

Specific Characters.—Shell small, subfusiform; whorls flattened, smooth, the last about half the total length, excavated below; spire polygyrate, acutely conical; mouth short, subquadrangular; outer lip thickened outside, grooved within; columella excavated, contorted; canal short, distinct.

Dimensions.—L. 10 mm. B. 4 mm.

Distribution.—Not known living.

Fossil: Waltonian Crag: Walton-on-Naze, Little Oakley. Newbournian: Shottisham. Upper and Middle Miocene: Italy.

Remarks.—Considerable difference of opinion has existed as to the correct nomenclature of the present species, Prof. Sacco referring it in 1890 to a new sub-genus *Clinurella* and in 1904 to *Atilia*, H. and A. Adams, as did M. Cossmann in 1901; Chenu, however, figured as the type of the latter genus a different form, *Columbella suffusa*, Sowerby.[2] I have adopted the sub-generic term *Colum-*

[1] There is a specimen from Waldringfield in the York Museum labelled *Lachesis magna* which I believe is the same as the present species.

[2] Man. Conch., vol. i, p. 201, fig. 1087.

bellopsis proposed in 1882 by MM. Bucquoy, Dautzenberg, and Dollfus for the group of Columbellidæ represented by *C. minor*, a shell in their opinion more nearly approaching *C. Borsoni*.[1] *C. Borsoni* was known to Wood from Walton. I have obtained several specimens at Oakley which seem to be the same. The fossil from the Italian Miocene now given for comparison I owe to the kindness of my good friend Prof. Sacco.

Genus **MITRA**, Lamarck, 1799.

Mitra ebenus, Lamarck. Plate XXXIII, fig. 4.

1811. *Mitra ebenus,* Lamarck, Ann. du Mus., vol. xvii, p. 216, no. 58.
1836–44. *Mitra ebenus* and vars., Philippi, Enum. Moll. Sic., vol. i, p. 229, pl. xii, figs. 8—10, 1836; vol ii, p. 195, 1844.
1850. *Mitra ebenus,* S. V. Wood, Mon. Crag Moll., pt. ii, p. 310, pl. xxxi, fig. 7.
1858. *Volutomitra ebenus,* H. and A. Adams, Gen. Rec. Moll., vol. i, p. 173.
1870. *Mitra ebenus,* A. Bell, Journ. de Conch., vol. xviii, p. 349, no. 301.
1875. *Mitra ebenus,* Seguenza, Boll. R. Com. Geol. Ital., vol. vi, p. 204, no. 114.
1878. *Mitra ebenus,* Monterosato, Enum. e Sinon. Conch. Medit., p. 48.
1878. *Mitra ebenus,* de Stefani ee Pantinelli, Bull. Soc. Malac. Ital., vol. iv, p. 111.
1883. *Mitra ebenus* and vars., Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 115, pl. xvi, figs. 1—7.
1890. *Mitra ebenus,* Carus, Prod. Faun. Medit., vol. ii, p. 406.
(?) 1894. *Mitra* sp., Kendall, Journ. Isle of Man Nat. Hist. Soc., vol. i, pp. 219, 222, no. 78, fig. 20.
1901. *Mitra ebenus* and vars., Kobelt, Icon. schalentrag. europ. Meeresconch., vol. ii, p. 47, pl. xli, figs. 2—23; pl. xliii, figs. 1—6.

Specific Characters.—Shell slender, solid, subfusiform; whorls slightly convex, smooth or with nearly obsolete costæ on the upper ones; suture distinct; mouth narrow, elongate; canal short, open; columella with 4 folds.

Dimensions.—L. 20 mm. B. 8 mm.

Distribution.—*Recent:* Mediterranean, west Atlantic as far south as the coasts of Morocco, the Canaries and the Cape Verde islands.

Fossil: Coralline Crag: Gedgrave. Waltonian: Little Oakley. Newbournian: Waldringfield. Isle of Man (?).

Oligocene and Miocene (B. D. D.).

Pliocene: Siena, Bologna, Biot.

Pleistocene: Sicily, Calabria, Tuscany.

Remarks.—Of this southern and rather variable form, known to Wood from the Coralline Crag only, I have one or two imperfect specimens from Oakley, and Mr. Bell has reported it from Waldringfield. It may be possibly derivative at the latter localities.

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[1] Moll. mar. Rouss., vol. i, p. 77.

Seguenza, identifying it with *M. cornicula*, includes it in his list of fossils from the Sicilian and Italian Pleistocene.

The specimen from the Isle of Man figured by Prof. Kendall (*loc. cit.*) as *Mitra sp.* may possibly belong to the present species.

Mitra cornicula (Linné). Plate XXXIII, figs. 2, 3.

1758. *Voluta cornicula*, Linné, Syst. Nat., ed. x, p. 731, no. 362.
1826. *Mitra lutescens*, Payraudeau, Moll. de Corse, p. 164, pl. vii, fig. 19.
1846. *Mitra cornea ?*, E. Forbes, Mem. Geol. Surv., vol. i, p. 428.
1858. *Volutomitra cornicula*, H. and A. Adams, Gen. Rec. Moll., vol i, p. 173.
1873–4. *Mitra cornicula* (*Voluta*), Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 296, no. 69, 1873; vol. v, p. 274, no. 28, 1874.
1883. *Mitra cornicula* (*Voluta*), Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 117, pl. xvi, figs. 10—13.
1890. *Mitra cornicula*, Carus, Prod. Faun. Medit., vol. ii, p. 407.
1901. *Mitra* (*Voluta*), *cornicula* Kobelt, Icon. schalentrag. europ. Meeresconch., vol. ii, p. 50, pl. xlii, pp. 13—23.

Specific Characters.—Shell solid, elongato-ovate, smooth; whorls 7, but slightly convex, gradually diminishing in size towards an acute apex, the last about half the total length or rather more, having a few inconspicuous striæ at the base; spire slender, acuminate; mouth long, narrow, angulate above, expanded and open below, with three folds on the columella; suture distinct but shallow.

Dimensions.—L. 20 mm. B. 6 mm.

Distribution.—*Recent:* Mediterranean, littoral zone, Atlantic coasts as far south as Senegal.

Fossil: Wexford gravels.

Oligocene ?, Miocene, Pliocene, Pleistocene (B. D. D.).

Remarks.—At first I was disposed to think that the Wexford fossil here given under this name was the *Volutomitra groenlandica* of Beck, insufficiently described by Möller in 1842, but not figured, so far as I know, until 1878 by Prof. G. O. Sars and since then in 1901 by Dr. Kobelt. The latter is a truly northern form and was reported from Wexford and doubtfully identified with *Mitra cornea* (*? M. cornicula*) by Prof. Ed. Forbes in 1846 (*op. cit*).

I have lately received from Dr. Odhner, however, a recent specimen of *V. groenlandica* which differs materially from the fossils in question, the spire of the latter being more slender and longer in proportion, the body-whorl shorter and less tumid, and the outer lip less expanded. I can hardly think they can be referred to *V. groenlandica*, even as a variety, approaching much more nearly the figures of the Mediterranean *M. cornicula* given by Dr. Kobelt, to which I think they may be more probably referred.

I am figuring Dr. Odhner's shell for comparison in connection with the next paragraph.

Our fossils are evidently waterworn; all trace of the foldings on the columella or of any spiral striation which may have formerly existed on them having been obliterated.

Genus **VOLUTOMITRA**, Gray, 1847.

Volutomitra groenlandica (Möller). Plate XXXIII, figs. 5, 6.

1842. *Mitra groenlandica* (Beck), Möller, Ind. Moll. Groenl., p. 15.

1846–59. *Mitra* sp., E. Forbes, Mem. Geol. Surv., vol. i, p. 428, 1846; *M. grœnlandica*, Nat. Hist. Europ. Seas, p. 262, 1859.

1851. *Mitra grœnlandica*, S. P. Woodward, Man. Moll., p. 356.

1853. *Mitra grœnlandica*, Gray, Ann. Mag. Nat. Hist. [2], vol. xii, p. 129.

1877. *Volutomitra grœnlandica*, Mörch in Rink, Dan. Greenl., p. 439.

1878. *Volutomitra grœnlandica*, G. O. Sars, Moll. Reg. Arct. Norv., pp. 244, 361, pl. xxiii, fig. 12.

1879–1915. *Volutomitra grœnlandica*, A. Bell, List of Rocks and Foss. at Worden, p. 17, 1879; Geol. Mag. [6], vol. ii, p. 168, 1915.

1887. *Volutomitra grœnlandica*, Fischer, Man. Conch., p. 610.

1899. *Volutomitra groenlandica*, Posselt, Medd. om Grønl, vol. xxiii, p. 171.

1901. *Volutomitra groenlandica*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. ii, p. 4, pl. xxix figs. 3—7.

1901. *Volutomitra grœnlandica*, Friele og Grieg., Norske Nordh. Exped. (Mollusca), pt. iii, p. 95.

1903. *Volutomitra grœnlandica*, Lamplugh, Mem. Geol. Surv., Isle of Man, p. 475.

1910. *Volutomitra grœnlandica*, Odhner, Archiv Zool., K. Svensk. Vet-Akad. Handl., vol. vii, no. 4, pp. 12, 24.

1916. *Volutomitra groenlandica*, Massy, Journ. of Conch., vol. xv, p. 48.

Specific Characters.—Differs in form from *Mitra cornicula* as stated above, it is fairly solid, fusiform, and smooth, except that it is ornamented by excessively fine spiral striæ, invisible without the aid of a strongly magnifying lens and by inconspicuous lines of growth, the last whorl being about three-fourths the length of the shell; apex obtuse; mouth equal in length to the spire; inner lip forming a very thin glaze on the columella which has 4 acute folds, the lowest less prominent than the others.

Dimensions.—L. 20 mm. B. 9 mm.

Distribution.—*Recent:* west coast of Ireland, Norwegian coast, Finmark, Iceland, Spitzbergen, Greenland.

Fossil: Isle of Man; Blackwater, Co. Wexford; Worden, near Preston, Lancashire.

Remarks.—I figure, with the recent shell received from Dr. Odhner alluded to above, a small specimen from the Wexford gravels, possibly immature or dwarf, which, except for its size, seems to correspond with it.

In his classical "Manual of the Mollusca" the late S. P. Woodward, including *V. groenlandica* in his list of Arctic species, mentions the fact that it occurs fossil in the latest British Tertiaries. Miss Massy has recently reported (*loc. cit.*) that it has been dredged by the Irish Fishery Board at 550 fathoms on the Atlantic slope of the west of Ireland.

Genus **NASSA,** Lamarck, 1799 (*continued from* p. 89).

A sub-division of this old and classical genus was proposed in 1853 by H. and A. Adams, including, for example, the use of the sub-generic name *Niotha* for the *Nassa clathrata* group, *Uzita* for that of *N. reticosa*, *Tritia* of *N. reticulata*,[1] *Hinia* of *N. incrassata*, *et cet.* For some years these names were not in such general use among Conchologists as is now the case.

I did not introduce them when dealing with the Nassas in my first part (pp. 61–89, 1914), my object being then to make my work a supplement to that of my old master, and for the convenience of students of the Crag to follow so far as practicable the methods employed by him. As time went on I found it desirable to introduce certain changes, the adoption of the sub-generic division of the present and some other groups being among them.

Nassa solida, S. V. Wood, MS.[2] Plate XXXIII, fig. 22.

1886. *Nassa solida*, S. V. Wood MS., *fide* Kendall and R. G. Bell, Quart. Journ. Geol. Soc., vol. xlii, p. 210.

1893–98. *Nassa solida*, A. Bell, Proc. Roy. Irish Acad. [3], vol. ii, p. 627, 1893; Trans. Roy. Geol. Soc. Cornwall, vol. xii, pp. 129, 140, pl. i, fig. 6, 1898.

Specific Characters.—Shell solid and massive; whorls 6 or 7, the last much the largest, depressed above; a few of the upper ones only are ornamented by short, oblique and closely-set costæ, the remainder of the shell by very fine, inconspicuous striæ, with stronger ones near the base, and faintly by the lines of growth; spire very short, regularly tapering to an acute point; suture slight; mouth oval, angulate above; outer lip curved, with a sharply-cut triangular notch where it joins the body-whorl, thickened outside, strongly denticulate internally, with a prominent tooth near the canal; inner lip forming a thin and rather narrow glaze upon the pillar; pillar excavated, ending abruptly, with a sharp edge against the short and hollowed canal.

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[1] The authors of the "Marine Mollusca of Roussillon" prefer the sub-generic name *Hinia* to *Tritia* for reasons there given (vol. i, p. 49, 1882).

[2] *N. solida* was first described in Mr. A. Bell's paper of 1898.

Dimensions.—L. 25 mm. B. 16 mm.

Distribution.—Not known living.

Fossil: St. Erth. Pliocene: Volhynia (R. Bell).

Remarks.—This shell, unrecorded as living and only known as a British fossil from St. Erth (where it is fairly common), is closely related to the recent *N. mutabilis*, Linné, with which it might almost be grouped as a variety. It differs from the latter, however, in size and form, and in certain other particulars stated below, and has been regarded as distinct by all the authors who have dealt with it. I retain Wood's name of *N. solida*, under which it has been known in our public collections for many years. R. G. Bell states that it occurs in the Pliocene deposits of Volhynia.

Our fossil approaches to some extent the *N. crassilabris* of Bellardi.[1]

Nassa mutabilis (Linné). Plate XXXIII, figs. 23—25.

1758. *Buccinum mutabile*, Linné, Syst. Nat., ed. x, p. 738, no. 398.
1814. *Buccinum mutabile*, Brocchi, Conch. foss. subap., vol. ii, p. 341, pl. iv, fig. 18.
1836–43. *Buccinum mutabile*, Philippi, Enum. Moll. Sic., vol. i, p. 222, 1836; vol. ii, p. 189, 1843.
1870–98. *Nassa mutabilis*, A. Bell, Journ. de Conch., vol. xviii, p. 345, no. 199, 1870; Proc. Roy. Irish Acad. [3], vol. ii, p. 626, 1893; Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 139, pl. i, fig. 4, 1898.
1873–5. *Nassa mutabilis*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 300, no. 139, 1873; vol. vi, p. 276, no. 255, 1875.
1882. *Nassa mutabilis* and vars., Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 42, pl. x, figs. 3—7.
1882. *Nassa mutabilis* and vars., Bellardi, Moll. Terr. Terz. Piem., pt. iii, p. 24, pl. i, figs. 20, 21.
1882. *Nassa mutabilis* and var. *Companyoi*, Fontannes, Moll. plioc. Vall. du Rhone, vol. i, p. 70, pl. v, figs. 14—16.
1885. *Nassa mutabilis*, S. V. Wood, Quart. Journ. Geol. Soc., vol. xli, p. 68.
1886. *Nassa mutabilis*, Kendall and R. G. Bell, Quart. Journ. Geol. Soc., vol. xlii, p. 210.
1887. *Nassa mutabilis*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, p. 122, pl. xxi, figs. 5—24; pl. xxii, figs. 1—14.
1890. *Nassa mutabilis*, Carus, Prod. Faun. Medit., vol. ii, p. 391.
1890–1904. *Nassa mutabilis* and vars., Sacco, Boll. Soc. Geol. Ital, vol. ix, p. 208, nos. 2536—40, 1890; Moll. Terr. Terz. Piem., pt. xxx, p. 63, pl. xv, figs. 26—29, 1904.
1890. *Nassa mutabilis*, C. Reid, Plioc. Dep. Brit., p. 248.
1892. *Sphæronassa mutabilis*, Locard, Coq. mar. Côtes de France, p. 74, fig. 61.
1901. *Nassa mutabilis*, Cossmann, Ess. Paléoconch. compar., vol. iv, p. 210, pl. ix, figs. 1, 2.
1901–7. *Nassa mutabilis*, Scalia, Att. Accad. Gioen. Sci. Nat. Catania [4], vol. xiv, p. 14, no. 175, 1901; vol. xx, p. 35, no. 312, 1907.
1911. *Nassa mutabilis* and vars., Cerulli-Irelli, Palaeont. Ital., vol. xvii, p. 244, pl. xxii, figs. 17—24.
1913. *Nassa mutabilis*, Gignoux, Ann. Univ. Lyon, n.s. [1], vol. xxxvi, p. 504.

Specific Characters.—Shell oval, oblique; whorls 7, convex, depressed above, the last more or less inflated, much the largest; spire short, rapidly diminishing

[1] Moll. Terr. Terz. Piem., pt. iii, p. 23, pl. i, fig. 18.

in size to an acute apex; ornamented by exceedingly fine inconspicuous striæ, and near the base by fine ridges; suture channelled, well-marked; mouth oval, angulate above; outer lip oblique, nearly straight upwards, rounded and expanded below, ornamented within by fine linear ridges (not by tubercles as in *N. solida*); inner lip forming a wide glaze on the pillar, ending abruptly against the deeply hollowed canal; canal very short, wide, open; pillar sinuous, excavated in the middle.

Dimensions.—L. 25—32 mm. B. 14—20 mm.

Distribution.—Recent: west Atlantic from Senegal and the Canaries to the coasts of Spain, Portugal and south-west France. Mediterranean, widely diffused. Adriatic, Ægean. Syrian coast, Egypt.

Fossil: St. Erth (not very rare).

Miocene (B. D. D.). Lower Pliocene: Biot. Italy (Bellardi).

Pliocene: Monte Mario, Colli Astesi (abundant), Bologna. Morocco (Lecointre).

Pleistocene: Sicily—Messina, Ficarazzi, Monte Pellegrino, Catania (Nizzeti), Sciacca. Calabria—Reggio, San Giovanni, Monteleone, Taranto, Gravina. Tuscany—Livorno, Vallé Biaia.

Remarks.—This characteristically southern species, which has been taken as the type form of *Nassa, sensu stricto,* has not been recorded from the Anglo-Belgian basin, though it is fairly common in the western Pliocene area at St. Erth.

It may be interesting to notice, as bearing upon the age of the latter deposit, that specimens of this species from St. Erth correspond more nearly with those from the Upper Pliocene of Asti, where it is very common, than with that now living in the Mediterranean, which closely resembles those of the late Pleistocene deposits of the sub-Etnæan beds of Nizzeti near Catania, as will be seen from the figure of a recent shell here given.

Examples of *N. mutabilis* from St. Erth differ from those of *N. solida* from the same place in size and solidity, in the longer and more tumid form of the body-whorl and in the internal decoration of the outer lip, which in *N. mutabilis*, as stated above, is linear and sometimes nearly obsolete, while in *N. solida* it is tubercular, with a strong and distinct tooth near the canal; in the upper whorls of the latter, moreover, the costation is stronger and the mouth is more oblique.

Our St. Erth specimens of *N. mutabilis* approach the *Buccinum inflatum* of Lamarck = *N. mutabilis*, var. *inflata* of Bucquoy, Dautzenberg and Dollfus, as to which the latter authors state that the internal decoration of the outer lip is sometimes wanting. The Sicilian form occurring at Nizzeti seems to be their variety *minor*.

Nassa mutabilis has not been reported from any horizon of the Anglo-Belgian Crag, nor has it been found fossil in the western area either in the Isle of Man or in the Wexford gravels.

Var. **erthensis,** S. V. Wood, MS. Plate XXXIII, fig. 26.

1886. *Nassa mutabilis,* var. *St. Erthensis,* S. V. Wood, MS., in Kendall and R. G. Bell, Quart. Journ. Geol. Soc., vol. xlii, p. 210.

1898. *Nassa mutabilis,* var. *St. Erthensis,* A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 140, pl. i, fig. 5.

Varietal Characters.—Much larger and longer than the type, the outer lip being more expanded, and the upper part of the whorls obtusely and obscurely angulate rather than rounded; in R. G. Bell's MS. sub-variety *gigantea* (*loc. cit.*) the whole of the shell is said to be spirally striated.

Dimensions.—L. 45—54 mm. B. 25—32 mm.

Distribution.—Not known living.

Fossil: St. Erth.

Remarks.—The principal difference between this form and the type is its much larger size, one of the specimens here represented attaining a length of 54 mm. Generally they are smaller, about 45 mm. Prof. Sacco figures a large variety of *N. mutabilis,* apparently thick and coarse-looking, with strong sculpture, under the name of var. *pliomagna* (*op. cit.*, pt. xxx, pl. xv, figs. 27, 28), but it does not altogether agree with the present shell.

No recent variety of *N. mutabilis* is known which approaches in size the present form. Taken as a whole the St. Erth Nassas are strikingly different from those of the English Crag, the common Red Crag species of that genus being almost without exception conspicuous by their absence. Mr. R. B. Newton regards the St. Erth fauna as older than that of the Coralline Crag.[1]

N. Caronis, Brongniart, a Miocene species, has a superficial resemblance to *N. mutabilis* and especially to the present variety, but it is now generally regarded as belonging to a different genus.[2]

Nassa Kennardi, F. W. Harmer. Plate XXXV, figs. 4, 5.

1897. *Buccinum (Cominella) aquitanicum,* A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 139.

1914. *Nassa Kennardi,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 87, pl. v, fig. 11.

Distribution.—Fossil: St. Erth. Scaldisien: Antwerp (additional).

Remarks.—One of the fossils here represented is from the Scaldisien of Antwerp, the other from the St. Erth collection at the British Museum, the latter having been identified with a Miocene shell, *Buccinum aquitanicum* (Mayer), from south-west France.[3] Comparing it, however, with a typical specimen of that form

[1] Journ. of Conch., vol. xv, p. 137, 1916.

[2] See figures in Hörnes, *op. cit.*, pl. xii, figs. 1—3.

[3] Journ. de Conch., vol. vii, p. 192, pl. iv, fig. 2, 1858.

received from my friend Prof. Peyrot, of Bordeaux, I doubt whether the two are identical, although they belong to the same group. I prefer therefore to regard them as specifically distinct.

In form and especially in sculpture, which is different from anything else I know from the Crag, our shells seem to agree with one described by me above as *N. Kennardi*, to which species I refer them.

Sub-genus **NIOTHA,** H. and A. Adams, 1853.

Nassa (Niotha) clathrata, var. A. (Born). Plate XXXIII, figs. 28—30.

1901. *Nassa (Niotha) clathrata*, Cossmann, Ess. Paléoconch. compar., vol. iv, p. 203, pl. ix, fig. 3.
1913. *Nassa (Niotha) clathrata*, var. *ficaratiensis*, Gignoux, Ann. Univ. Lyon, n.s. [1], vol. xxxvi, p. 504, pl. xv, figs. 10, 11.
1914. *Nassa clathrata*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 66, pl. iii, fig. 3.

Dimensions.—L. 24—34 mm. B. 14—18 mm.

Distribution.—Fossil: Coralline Crag: Gomer pit, Gedgrave, Boyton. Waltonian: Little Oakley.

Upper and Lower Pliocene: Italy—Vasto.

Pleistocene: Girgenti, Castellamare, Monte Pellegrino, Ficarazzi.

Remarks.—The specimens of *N. clathrata* (Pl. XXXIII, figs. 29, 30) from the Gomer pit and from Boyton respectively, both belonging to the Sedgwick Museum at Cambridge, are apparently the variety A. of Born, corresponding more nearly with Bellardi's figure of that form than with the one given in Part I of this work (*loc. cit.*). Bellardi shows the present variety to be somewhat longer than the type and less distinctly turreted, the costæ and the spiral ridges being more numerous and closely-set. My fig. 28 of Pl. XXXIII from Asti represents the typical form of the Italian Pliocene; our Crag shells seem rather to agree with the variety *ficaratiensis* of the Marchese di Monterosato, as figured by M. Gignoux. The latter author records this variety from the Calabrian zone of Vasto in the Abruzzi and from the Sicilian of Ficarazzi and Monte Pellegrino.

The sub-genus *Niotha*, of which the present species is taken as the type, includes a group of the Nassidæ of moderate size, ventricose in form, with a short spire, deep suture, cancellate sculpture, the outer lip not varicose, but thickened and grooved internally; mouth without a notch at the upper angle as in *Hinia*, with a large callus on the inner lip.

Nassa (Niotha) emiliana (Mayer). Plate XXXV, fig. 6.

1901. *Nassa (Niotha) emiliana*, Cossmann, Ess. Paléoconch. compar., vol. iv, p. 204.
1914. *Nassa emiliana*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 67, pl. iv, figs. 5, 6.

Remarks.—Among the St. Erth fossils in the Sedgwick Museum at Cambridge is a minute specimen, measuring only 9 mm. in length, which has been identified by Mr. A. Bell as *N. emiliana.*

It differs from those described and figured in Part 1 of this work (*loc. cit.*) in its more delicate sculpture and especially in size. It may be an immature shell or possibly a dwarf form of the present species; the interior of the mouth is denticulated within.

M. Cossmann includes also *N. ligustica* and *N. Cantrainii* (figured in my Pl. III) in the present (*Niotha*) group, the distinguishing characters of which are fully stated in his fourth volume, p. 203.

Sub-genus **HINIA** (Leach), Gray,[1] 1847.

Nassa (Hinia) reticulata (Linné). Plate XXXIV, figs. 1, 2.

1758. *Buccinum reticulatum*, Linné, Syst. Nat., ed. x, p. 740, no. 411.
1853. *Nassa reticulata*, Forbes and Hanley, Brit. Moll., vol. iii, p. 388, pl. cviii, figs. 1, 2.
1856. *Buccinum reticulatum*, Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 151, pl. xii, fig. 18.
1867–9. *Nassa reticulata*, Jeffreys, Brit. Conch., vol. iv, p. 346, 1867; vol. v, p. 219, pl. lxxxvii, fig. 3, 1869.
1870–92. *Nassa reticulata*, A. Bell, Journ. de Conch., vol. xviii, p. 346, no. 201, 1870; Rep. Brit. Assoc. (Bath), pp. 135, 138, 139, 1888; (Leeds) pp. 414, 417, 420, 1890; Rep. Yorks. Phil. Soc., pp. 63, 70, 1892.
1871–7. *Nassa reticulata*, F. W. Harmer, Trans. Norf. and Norw. Nat. Soc., vol. i, pt. iii, p. 42, 1871; in Skertchly, Mem. Geol. Surv. (Fenland), p. 202, 1877.
1872. *Nassa reticulata*, S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. i, p. 14, pl. vi, fig. 5.
1873–5. *Nassa reticulata*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 300, no. 146, 1873; vol. vi, p. 276, no. 263, 1875.
1874. *Nassa reticulata*, Darbishire, Quart. Journ. Geol. Soc., vol. xxx, p. 40.
1882. *Nassa reticulata*, Bellardi, Moll. Terr. Terz. Piem., pt. iii, p. 47, pl. iii, fig. 7.
1882. *Nassa (Hinia) reticulata*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 49, pl. x, figs. 8, 9.
1886. *Nassa (Hinia) reticulata*, Dollfus et Dautzenberg, Feuilles jeunes Nat. Paris, vol. xvi, p. 103.
1887. *Nassa reticulata*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, p. 135, pl. xxiv, figs. 1—15, 23—25; pl. xxv, figs. 1—3, 5.
1890. *Nassa reticulata*, Carus, Prod. Faun. Medit., vol. ii, p. 392.
1890–1904. *Nassa reticulata*, Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 210, no. 2584, 1890; *N. (Hinia) reticulata* and vars., Moll. Terr. Terz. Piem., pt. xxx, p. 64, 1904.
1894. *Nassa reticulata*, Kendall, Journ. Isle of Man Nat. Hist. Soc., vol. i, p. 419.
1901. *Nassa reticulata*, Brøgger, Norges geol. Undersøgelse, no. 31, p. 662, pl. ix, fig. 6.
1901. *Nassa (Hinia) reticulata*, Cossmann, Ess. Paléoconch. compar., vol. iv, p. 204.
1901–7. *Nassa (Zeuxis) reticulata*, Scalia, Atti Accad. Gioen. Sci. Nat. Catania, vol. xiv, p. 8, no. 121, 1901; vol. xx, p. 35, no. 314, 1907.

[1] Not to be confounded with *Hinea*, Gray. H. and A. Adams use the sub-generic term *Tritia* of Risso for this group.

1911. *Nassa reticulata*, Cerulli-Irelli, Palaeont. Ital., vol. xvii, p. 247, pl. xxii, figs. 29, 30.
1913. *Nassa (Hinia) reticulata*, Gignoux, Ann. Univ. Lyon, N.S. [1], vol. xxxvi, p. 507.

Specific Characters.—Shell thick and strong with a wide base; whorls but little convex, the last excavated and pinched up at the back of the canal; ornamented by strong longitudinal ribs, about 15 on the body-whorl, equal to the intervening spaces, finer, more numerous and closer together on the upper ones, also by rather deep spiral striæ which cause slight tuberculation on the ribs; spire elongato-conical, ending in a blunt point; suture slight; mouth oval, angulate above; outer lip nearly straight above, rounded below, thickened and toothed internally; inner lip fluted below, forming a thick and wide glaze on the pillar; canal very short, open, turning to the left.

Dimensions.—L. 18—28 mm. B. 12—15 mm.

Distribution.—*Recent:* common throughout British Seas, and abroad from Norway to the Mediterranean and the Azores.

Fossil: Wexford, Isle of Man. Generally distributed in the Pleistocene deposits of Great Britain.

Miocene: Touraine, Vienna basin.

Lower Pliocene: Albenga, Vezza, Bordighera, Biot.

Upper Pliocene: Monte Mario, Altavilla, Val d'Era, Bologna, Livorno.

Pleistocene: Ficarazzi, Monte Pellegrino, Messina, Catania, Reggio, Monteleone, Taranto, Gravina, Livorno, Valle Biaia.

Tapes-banks in Christiania fiord (Brøgger). Trondhjem (Øyen). Uddevalla.

Remarks.—This common and wide-spread British and continental species has not been recorded from the Pliocene deposits of the Anglo-Belgian basin, although it is said by continental authorities to go back to Miocene times and has been found at many localities in the Pliocene and Pleistocene of the south of Europe. It is a characteristic and rather abundant form of the British Pleistocene, occurring also in the western area in Manxland and the Wexford gravels, at March and Kelsea Hill in the east, and at Selsey with its comparatively southern fauna in the south. It is said to be rather rare in the Scottish Pleistocene but abundant in the high-level drifts of Lancashire and especially in those of Ireland. Prof. Brøgger includes it among his list of Lusitanian fossils from the *Tapes*-banks of the Christiania fiord and Dr. Øyen reports it from the Pleistocene of Trondhjem.

The present species, taken as typical of the *Hinia* group of the Nassidæ, is allied to *Niotha* but is not ventricose, the parietal folding is absent, the outer lip being denticulated within and not grooved as in that sub-genus.

Var. **nitida** (Jeffreys). Plate XXXIV, figs. 3—5.

1826. *Buccinum reticulatum*, Blainville, Faun. franc., p. 172, pl. vii, fig. 1.
1826. *Planaxis mammilata*, Risso, Hist. Nat. Europ. mérid., vol. iv, p. 178, no. 459, pl. ix, fig. 122.

1867–9. *Nassa nitida*, Jeffreys, Brit. Conch., vol. iv, p. 349, 1867; vol. v, p. 219, pl. lxxxvii, fig. 4, 1869.

1870–92. *Nassa nitida*, A. Bell, Journ. de Conch., vol. xviii, p. 346, no. 207, 1870; Rep. Brit. Assoc. (Bath), pp. 135, 139, 1888; (Leeds), pp. 417, 420, 1890; Ann. Rep. Yorks. Phil. Soc., p. 63, 1892.

1872–7. *Nassa nitida*, F. W. Harmer, Trans. Norf. and Norw. Nat. Soc., vol. i, pt. iii, p. 46, 1872; in Skertchly, Mem. Geol. Surv. (Fenland), p. 202, 1877.

1882. *Nassa reticulata*, var. A, Bellardi, Moll. Terr. Terz. Piem., pt. iii, p. 48, pl. iii, fig. 6.

1882. *Nassa reticulata*, var. *nitida*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 51, pl. x, figs. 10, 11.

1887. *Nassa reticulata*, var., Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, p. 136, pl. xxiv, figs. 16—22; pl. xxv, fig. 4.

1890. *Nassa reticulata*, var. *nitida*, Carus, Prod. Faun. Medit., vol. ii, p. 393.

1911. *Nassa reticulata*, var. *nitida*, Cerulli-Irelli, Palaeont. Ital., vol. xvii, p. 247, pl. xxii, figs. 31—34.

1913. *Nassa reticulata*, var. *nitida*, Gignoux, Ann. Univ. Lyon, n.s. [1], vol. xxxvi, p. 507.

Varietal Characters.—Differs from the type in size, in its fewer and stronger longitudinal costæ which are more prominent than the transverse striæ, and not so distinctly granulate; the spire is turreted and shorter in comparison; the inner lip is thinner and not denticulate, the pillar having a slighter fold.

Dimensions.—L. 18—24 mm. B. 12—15 mm.

Distribution.—*Recent:* Falmouth, muddy estuaries of the Thames and Orwell, Norfolk coast with *N. reticulata*, probably elsewhere in Great Britain.

Brittany, Mogador, Adriatic, Portuguese coast. Mediterranean, Cannes, Nice, Orbitello, Cette (Carus).

Fossil: Hunstanton, March, Nar Valley, Bridlington, Selsey, Worden (A. Bell), Wexford, Killiney, Irish estuarine clays.

Italian Pliocene: Vezza, Monte Mario and elsewhere. Biot.

Remarks.—Originally described by Jeffreys, though with some misgiving, as specifically distinct, it has been regarded more generally as a variety of *N. reticulata*. Jeffreys' view appears to have been based principally on the belief that the two forms had not been found living together, but I have obtained both, not only recent at Brancaster on the Norfolk coast, but fossil also in some neighbouring Pleistocene gravels at Hunstanton. It might probably be met with elsewhere in British seas if specially looked for. According to Jeffreys *N. nitida* is a brackish water rather than a marine form, characteristic of muddy estuaries. Dr. Gignoux regards it as more littoral than the type *N. reticulata*. It closely resembles the fossil figured by Risso in 1826 (*op. cit.*) as *Planaxis mammilata*, as well as the recent shell described by Blainville (*op. cit.*) as *Buccinum reticulatum*.

Nassa (Hinia) recticostata (Bellardi). Plate XXXIII, fig. 27.

1882. *Nassa recticostata*, Bellardi, Moll. Terr. Terz. Piem., pt. iii, p. 45, pl. iii, fig. 2.

1885. *Nassa recticostata*, S. V. Wood, Quart. Journ. Geol. Soc., vol. xli, p. 68.

1886. *Nassa recticostata*, Kendall and R. G. Bell, Quart. Journ. Geol. Soc., vol. xlii, p. 210.

1890. *Nassa recticostata*, Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 210, no. 2580.

1890. *Nassa recticostata*, C. Reid, Plioc. Dep. Britain, p. 248.

1893–8. *Nassa recticostata*, A. Bell, Proc. Roy. Irish Acad. [3], vol. ii, p. 626, 1893; Trans. Roy. Geol.. Soc. Cornwall, vol. xii, p. 140, pl. i, fig. 8, 1898.

1901. *Nassa* (*Hinia*) *recticostata*, Cossmann, Ess. Paléoconch. compar., vol. iv, p. 205.

Specific Characters.—Shell small, oval, acutely conical; whorls 6, but very slightly convex, regularly diminishing upwards to a rather blunt, rounded apex; ornamented by more or less rectilinear costæ, about 15 on the body-whorl, nearly equal to the intervening spaces, which do not altogether reach the base of the shell, and by very fine, closely-set spiral ridges crossing the ribs; suture slight; mouth small and narrow, angulate above; outer lip thickened, denticulate within, the upper denticle being much the largest; inner lip also denticulate, forming a thick callus on the pillar; canal turning to the left.

Dimensions.—L. 8 mm. B. 3·5 mm.

Distribution.—*Recent:* (?).

Fossil: St. Erth.

Upper Pliocene: Piedmont (very rare).

Remarks—This shell, which is more or less abundant at St. Erth, was identified by Wood with *N. recticostata*, a form originally described by Bellardi as rare in the Astian deposits of Piedmont. M. Dollfus has expressed the opinion, however, that it is identical with *Buccinum costellatum*, Renier, first figured under that name by Brocchi, but both Bellardi and Prof. Sacco doubt the identity of these two species. Our fossil approaches very nearly some of the numerous varieties of *N. costellata* figured by Messrs. Bucquoy, Dautzenberg and Dollfus, a group which includes *N. Cuvieri*, Payraudeau, *Buccinum variabile*, Philippi, and other similar forms. It resembles also some of the figures of *N. costellata* given by Prof. Kobelt; on the other hand it appears to me to differ materially from Brocchi's original representation of *B. costellatum.* As the matter is evidently one of doubt, I content myself with adopting provisionally Wood's reference of the St. Erth fossil to *N. recticostata*, in which he has been followed by the brothers Bell, Prof. Kendall and Mr. C. Reid; this is the name, moreover, by which it has been known for many years in all our collections.

Nassa (Hinia) trivittata (Say). Plate XXXIV, figs. 16, 17.

1821. *Nassa trivittata*, Say, Journ. Acad. Nat. Sci. Philad. [1], vol. ii, p. 231.

1841–70. *Nassa trivittata*, Gould, Rep. Invert. Mass., ed. 1, p. 309, fig. 211, 1841; ed. 2, p. 364, fig. 632, 1870.

1858. *Nassa* (*Tritia*) *trivittata*, H. and A. Adams, Gen. Rec. Moll., vol. i, p. 122.

1885. *Nassa trivittata*, S. V. Wood in J. Starkie Gardner, Quart. Journ. Geol. Soc., vol. xli, p. 96.

1914. *Nassa trivittata*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 73.

1915. *Alectrion (Tritia) trivittata*, Johnson, Bost. Soc. Nat. Hist., Occ. Papers, vol. vii; Fauna of New England, no. 13, p. 135.

Specific Characters.—Shell rather thin, ovato-conical, turreted; whorls 7 or 8, but slightly convex, with a narrow and square shoulder above; spire regularly diminishing upwards to a sharp and pointed apex; ornamented by strong, equal and equidistant spiral ridges, 4 on the upper ones and 10 on the body-whorl, intersected by numerous fine costæ which produce distinct granulation at the points of contact; mouth oval, notched at the upper angle; outer lip thin, grooved within by the spiral ridges; inner lip forming a thin glaze on the columella; canal short, notched, rather wide, turning to the left with a distinct groove at the back.

Dimensions.—L. 15 mm. B. 8 mm.

Distribution.—Recent: eastern coasts of North America.
Fossil: Pleistocene deposits, Macclesfield.
Pliocene: Iceland—Husavik.

Remarks.—There is a fossil in the British Museum from the Macclesfield drift which has been there identified with the recent New England species *N. trivittata*, Say. It corresponds very closely with an example of the latter I have received from Mr. C. W. Johnson of the Boston Society of Natural History. I have figured these side by side with some specimens of *N. propinqua* from the Oakley Crag to show wherein they agree and wherein they differ. The two forms are not the same but they belong to the same group; whether they should be regarded as specifically distinct has been and probably will continue to be a matter of opinion. On the whole it seems most convenient to retain the American name of *N. trivittata* for the one which is a recent and, as now ascertained, a Pliocene Icelandic, as well as a Pleistocene form, *N. propinqua* being reserved for the extinct and Pliocene shell of the Anglo-Belgian basin. It is interesting, however, to find this link between the molluscan faunas of the two continents. Possibly the newer is a modified descendant of the older shell.

By H. and A. Adams this American species was referred to the sub-genus *Tritia* of Risso (= *Hinia*, Leach), a view which has been recently adopted by Mr. C. W. Johnson of the Boston Society of Natural History.

N. trivittata was recognized by Wood among some fossils collected by Mr. J. Starkie Gardner from the Icelandic Crag of Husavik.

Nassa (Hinia) propinqua (J. Sowerby). Plate XXXIV, figs. 18, 19.

1914. *Nassa propinqua*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 73.

Remarks.—For reasons just given I now propose to regard this shell as specifically distinct from the American *N. trivittata*, to which, however, it is closely allied. As a Pliocene fossil it is only known from the Anglo-Belgian region, being very

common in the Waltonian Crag of Little Oakley where I have found hundreds of specimens. It varies in size but retains always the same general character. It seems to have a zonal value.

Sub-genus **TELASCO**, H. and A. Adams, 1853.

Nassa (Telasco) costulata (Renieri).

1804. *Buccinum costulatum*, Renieri, Tab. Alfab. Conch. Adriat.
1814. *Buccinum costulatum*, Brocchi, Conch. foss. subap., vol. ii, p. 343, pl. v, fig. 9.
1826. *Buccinum Cuvieri*, Payraudeau, Moll. de Corse, p. 163, pl. viii, figs. 17, 18.
1836–44. *Buccinum variabile*, Philippi, Enum. Moll. Sic., vol. i, p. 221, pl. xii, figs. 1—7, 1836; vol. ii, p. 188, 1844.
1878. *Nassa Cuvieri*, Monterosato, Enum. e Sinon. Conch. medit., p. 43.
1882. *Nassa costulata*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 52, pl. xi, fig. 15.
1901. *Nassa* (*Telasco*) *costulata*, Cossmann, Ess. Paléoconch. compar., vol. iv, p. 212.

Var. **tenuicosta,** Bucquoy, Dautzenberg and Dollfus. Plate XXXIV, figs. 25, 26.

1882. *Nassa costulata*, var. *tenuicosta*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 55, pl. xi, fig. 30—32.

Specific and Varietal Characters.—Shell solid, small, ovato-conical; whorls but slightly convex; ornamented by numerous longitudinal costæ which extend to the base of the shell, and by very fine spiral ridges; mouth oval, with a small sinus above; outer lip thickened by the labial rib, denticulated within; inner lip forming a distinct glaze on the pillar; canal very short, notched, pinched up at the back.

Dimensions.—L. 8 mm. B. 4 mm.

Distribution.—*Recent:* Mediterranean.

Fossil: Waltonian Crag: Little Oakley.

Remarks.—I make no apology for figuring this fragmentary fossil from Oakley, together with a recent shell received from the Marchese di Monterosato with which, so far as it goes, it appears to correspond. It seems different from anything I have noticed before from the Crag, belonging to the group of shells variously known as *N. Cuvieri*, *N. varicosa*, etc., which, as before stated, have been associated by the authors of the 'Mollusca of Roussillon' as varieties of the southern species *N. costulata*.[1] The Marchese, however, prefers to regard it as specifically distinct.

The name *N. Cuvieri* appears in Jeffreys' list of Red Crag shells on the authority of Mr. A. Bell. For reasons given on p. 82 I venture to think that the shell in question, described by the latter as *N. variabilis*, was a different species, viz. the *N. pusillina* of S. V. Wood.

The sub-genus *Telasco* is described by Adams as having an elevated spire,

[1] Not the *N. costellata* of p. 321, which has been regarded as belonging to a different group.

smooth and polished whorls, a spreading inner lip and an outer lip, simple and acute. *N. costulata* has been taken as the type form.

Sub-genus **HIMA** (Leach) H. and A. Adams, 1853.

Nassa (Hima) incrassata (Ström). Plate XXXIV, figs. 8—10.

1768. *Buccinum incrassatum*, Ström, Kongl. Norsk. Vid.-Selsk. Skrift., vol. iv, p. 369, pl. xvi, fig. 25.
1846. *Nassa incrassata*, Forbes, Mem. Geol. Surv., vol. i, p. 427.
1867–69. *Nassa incrassata*, Jeffreys, Brit. Conch., vol. iv, p. 351, 1867; vol. v, p. 219, pl. lxxxviii, fig. 1, 1869.
1870–1911. *Nassa incrassata*, A. Bell, Journ. de Conch., vol. xviii, p. 346, no. 210, 1870; Rep. Brit. Assoc. (Bath), p. 135, 1888; (Leeds), p. 420, 1890; Rep. Yorks. Phil. Soc., pp. 63—70, 1892; Journ. Ipswich Field Club, vol. iii, p. 16, 1911.
1873–5. *Nassa incrassata*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 300, no. 150, 1873; vol. vi, p. 278, no. 281, 1875.
1874. *Nassa incrassata*, Darbishire, Quart. Journ. Geol. Soc., vol. xxx, p. 40.
1881. *Nassa incrassata*, Nyst, Conch. Terr. tert. Belg., p. 25, pl. ii, fig. 7.
1882. *Nassa (Tritonella) incrassata*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 45, pl. xi, figs. 3—7.
1882. *Nassa incrassata*, Bellardi, Moll. Terr. Terz. Piem., pt. iii, p. 100, pl. vi, fig. 18.
1887. *Nassa incrassata* and vars., Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, p. 152, pl. xxvi, figs. 16—25; pl. xxvii, figs. 1—8.
1890. *Nassa incrassata*, Carus, Prod. Faun. Medit., vol. ii, p. 394.
1892. *Nassa incrassata*, Van den Broeck, Bull. Soc. Belg. Géol., vol. vi (Mémoires), p. 147.
1892–7. *Nassa incrassata*, Locard, Coq. mar. Côtes de France, p. 78, fig. 65, 1892; Exped. scient. Travailleur et Talisman, vol. i, p. 276, 1897.
1901. *Nassa (Hima) incrassata*, Cossmann, Ess. Paléoconch. compar., vol. iv, p. 210, pl. ix, figs. 6, 7.
1901–7. *Nassa (Zeuxis) incrassata*, Scalia, Atti Accad. Gioen. Sci. Nat. Catania [4], vol. xiv, p. 8, no. 120, 1901; vol. xx, p. 35, no. 313, 1907.
1912. *Nassa incrassata*, Dautzenberg et Fischer, Camp. Scient. Pr. Monaco, vol. xxxvii (Mollusques), p. 139.
1913. *Nassa incrassata*, Gignoux, Ann. Univ. Lyon, n. s. [1], vol. xxxvi, p. 510.

Specific Characters (of type form).—Shell thick and solid; whorls 7—8, convex, the last tumid, excavated at the base, with a deep groove at the back of the canal which gives it a pinched-up appearance; spire rather short, conical, regularly diminishing in size towards the apex: suture fairly deep; ornamented by strong flexuous costæ, about 15 on the last whorl, crossed by well-marked spiral ridges, more or less thickened or sub-granulate where they intersect; mouth oval, acutely angulated above; outer lip much thickened by the labial rib, toothed or fluted within; inner lip reflected on the pillar, also fluted internally; canal very short.

Dimensions.—L. 13 mm. B. 7 mm.

Distribution.—*Recent:* widely diffused, with its varieties, from Iceland and

Finmark to the Azores, Morocco, Senegal (Locard), Mediterranean, Adriatic, Ægean, Syria, Egypt.

Fossil: English Crag, upper zones, not common. Belgium: Poederlien (Van den Broeck). Wexford, Isle of Man (A. Bell). British Pleistocene: widespread.

Lower Pliocene: Biot, Roussillon, northern Italy.

Upper Pliocene: Italy—Valle Andona, Val d'Era, Bologna.
Sicily—Altavilla.

Pleistocene: Sicily—Messina, Monte Pellegrino, Nizzeti.
Italy—Livorno, Valle Biaia, Reggio, Taranto, Gravina.
Christiania fiord, Trondhjem, Uddevalla.

Remarks.—When the history of the Pliocene epoch comes to be written, particulars as to the occurrence of certain species, or even varieties, at certain localities or horizons, which now seem unimportant, may prove interesting and useful. Much has been written about the present species, indeed MM. Dautzenberg and Fischer, in their great work published in 1912 under the auspices of the Prince of Monaco, have given a list of nearly 300 papers, of more or less importance, dealing with the subject. Perhaps I may add a few notes on the distribution, in time or space, of some of the varietal forms which have been grouped under the present specific name.

In 1882 Bellardi described a fossil from the Italian Pliocene as *N. incrassata*, recording it from both the Upper and Lower horizons of those deposits. It is more delicate than the common British *N. incrassata*, with a longer and more slender spire and more convex whorls, but it has the thickened lip characteristic of this species, of which it is considered a variety. I have this form in my collection both from the Lower Pliocene *argiles bleues* of Bordighera, and the Upper Pliocene deposits of Asti, but I do not know it as recent in British seas.

The typical British variety is not common in the Crag. It does not occur in the list of mollusca reported by the late Robert Bell and Prof. Kendall from Walton, and I have not met with it during my many years' work at Oakley. It has been found, however, though not commonly, in the later Red Crag and in the Icenian. A thickened form is exceedingly abundant, however, in the Wexford gravels (fig. 8), but it is the northern variety β of my p. 88, very common in the Christiania fiord, and apparently the one figured by Profs. G. O. Sars and Brøgger which, so far as my information goes, is more frequently found in the later beds of the Red, and in the Icenian Crag.

If Nyst's figure of *N. incrassata* from the Scaldisien of Belgium (*op. cit.*) is correctly drawn, the shell given by him under that name is possibly a different species.

M. Van den Broeck does not include it in any of his lists from that horizon, though it is given by him in a later paper from the Poederlien deposits of Antwerp as something new to the Belgian Crag.

While a part of the Manx-Wexford mollusca have a distinctly Pliocene facies, the Nassas do not indicate any close connection between the eastern and the western Pliocene fauna. One misses in the deposits of the latter region the species of *Nassa* so constantly and so abundantly present in the Red Crag, especially in the earlier part of it, such as the many different varieties of *N. reticosa*, *N. granulata*, *N. propinqua*, and *N. elegans*, which are either unrecorded or but very rarely met with in the western area; the two most abundant species of the latter being *N. incrassata* and *N. reticulata*, both of them common as recent on the British coasts, but as fossil, representative in the east of England of the Pleistocene rather than of the Pliocene deposits, although dating back in other areas to Miocene times.

The *Himæ* are small shells with a short canal, a thickened and varicose lip denticulated within, and a reticulated sculpture, *N. incrassata* being taken as the type. Some other of the smaller species described in my first part, such as *N. elegans*, *N. consociata*, *N. granulata*, and *N. turonica* are included in this group.

Var. β. Plate V, figs. 25, 26.

1848. *Nassa incrassata*, S. V. Wood, Mon. Crag Moll., pt. i, p. 29, pl. iii, fig. 4.
1868. *Nassa incrassata*, G. O. Sars, Moll. Reg. Arct. Norv., pp. 253, 362, pl. xxiv, fig. 1.
1901. *Nassa incrassata*, Brøgger, Norges geol. Undersøgelse, no. 31, p. 658, pl. xviii, fig. 24.
1910. *Nassa incrassata*, Øyen, Kongl. Norske Vid.-Selsk. Skrift., no. ix, pp. 27 *et seq*.
1915. *Nassa incrassata*, var. β, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 88, pl. v, figs. 25, 26.

Varietal Characters.—Smaller, thinner, and more delicate than the type, with finer sculpture.

Remarks.—The Butley specimen shown on Pl. V, fig. 25, represents, as far as my experience goes, the variety most commonly found in the later zones of the Crag; those from Wexford are all of the strong and British type. The two figures should be compared.

Nassa (Hima) pygmæa (Lamarck). Plate XXXIV, figs. 6, 7.

1822–43. *Ranella pygmæa*, Lamarck, Hist. nat. Anim. sans Vert., vol. vii, p. 154, no. 14, 1822; ed. 2 (Deshayes), vol. ix, p. 550, no. 14, 1843.
1826. *Tritonia varicosa*, Turton, Zool. Journ., vol. ii, p. 365, pl. xiii, fig. 7.
1853. *Nassa pygmæa*, Forbes and Hanley, Brit. Moll., vol. iii, p. 394, pl. cviii, figs. 5, 6.
1867–71. *Nassa pygmæa*, Jeffreys, Brit. Conch., vol. iv, p. 354, 1867; vol. v, p. 219, pl. lxxxviii, fig. 2, 1869; in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 489, 1871.
1850–72. *Nassa pygmæa*, S. V. Wood, Mon. Crag Moll., pt. ii, p. 315, pl. xxxi, fig. 5, 1850; 1st Suppl., pt. i, p. 12, pl. vi, fig. 6, 1872.
1872. *Nassa pygmæa*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 213.
1873. *Nassa pygmæa*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 300, no. 151.

1880. *Nassa pygmæa*, Stewart, Proc. Belfast Nat. Field Club, Appendix, p. 176.

1881. *Nassa pygmæa*, Nyst, Conch. Terr. tert. Belg., p. 26, pl. ii, fig. 8.

1882. *Nassa (Tritonella) pygmæa*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 47, pl. xi, figs. 11—14.

1887. *Nassa varicosa*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, p. 156, pl. xxvii, figs. 9—14 (*N. granulata* on plate); figs. 18, 19.

1890. *Nassa pygmæa*, Carus, Prod. Faun. Medit., vol. ii, p. 395.

1890. *Nassa pygmæa*, C. Reid, Plioc. Dep. Brit., p. 248.

1901. *Nassa pygmæa*, Brøgger, Norges geol. Undersøgelse, no. 31, p. 662, pl. xvi, fig. 24.

1901–7. *Nassa (Zeuxis) varicosa*, Scalia, Atti Accad. Gioen. Sci. Nat. Catania [4] vol. xiv, p. 8, no. 122, 1901; vol. xx, p. 35, no. 315, 1907.

Specific Characters.—Shell smaller and more delicate than *N. incrassata*, with finer longitudinal sculpture, the points of intersection being distinctly granulate, labial rib large and prominent; one or more of the whorls having a conspicuous varix; suture not so deep as in *N. incrassata;* canal rather wider; internal sculpture of the outer lip more distinctly denticulate and prominent.

Dimensions.—L. 10 mm. B. 6 mm.

Distribution.—*Recent:* Coralline zone on the coasts of South Devon, Dorset, and Cornwall (Jeffreys). Connemara, Bantry Bay, Dublin Bay, Antrim.

West European: Mediterranean (generally diffused), Ægean, Black Sea, Crimea.

Fossil: Coralline Crag: Sutton (?). Butleyan: Butley. Wexford (A. Bell).

Pleistocene: Nar brickearth, Holderness drift, Selsey, Worden, Irish estuarine clays. Boulder Clay: Ireland.

Scaldisien: Heyst (Belgium).

Pleistocene: Reggio (Seguenza). Sub-Etnæan beds, Nizzeti, San Paulo (Scalia). *Tapes*-banks, Christiania fiord.

Remarks.—*N. pygmæa* belongs to the *incrassata* group, but may be distinguished from that species by its finer longitudinal sculpture and by the presence of a strong conspicuous varix on at least one of the lower whorls, probably the labial rib, as Jeffreys points out, of a former stage of repose during the growth of the organism.

Wood records it with some doubt from the Coralline Crag of Sutton, but Jeffreys was disposed to regard the unique specimen known from that place as a variety of *N. incrassata.* Both Wood and Jeffreys, however, report it, on the authority of Mr. A. Bell, from the Red Crag of Butley. Unfortunately Mr. Bell's shell cannot now be found. For the assistance of collectors, who should look out for it, I have figured a recent specimen from the Mediterranean; it may have been taken at other Crag horizons, not improbably, for a dwarf form of some other species. I have also given an example from the Rose collection at the Norwich Museum, obtained from some sections, now inaccessible, in the Post-Pliocene brickearth of the Nar valley.

Nyst reported a unique specimen of *N. pygmæa* from the Scaldisien of Heyst near Antwerp, but his drawing is not quite typical of that species, nor have M. Van den Broeck and other continental authorities recognised it as a Belgian fossil.

It appears at present to be a comparatively southern form, only just reaching as far north as the western part of the English Channel and to certain localities on the Irish coast; it is reported by Prof. Brøgger as occurring in the colony of Lusitanian shells which occupied the Christiania fiord during the later stages of the Pleistocene epoch, and Dr. Scalia records it, under Turton's name of *N. varicosa*, from the very recent fossiliferous beds on the flanks of Mount Etna already alluded to.

MM. Bucquoy, Dautzenberg, and Dollfus identify the present species with the *Buccinum tritonium* of Blainville.

Nassa (Hima) turonica (Deshayes). Plate XXXIV, figs. 11—14.

1898. *Nassa granifera, N. Jani, N. Perrieriæ*, A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 142.
1914. *Nassa turonica*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 85, pl. v, figs. 14, 15.

Remarks.—As stated above (p. 85), I follow the authors of the 'Mollusca of Roussillon' in substituting the name *Nassa turonica*, Deshayes, for *N. granifera*, Dujardin, by which the present species was formerly known to students of the Crag.

In his paper on the Pliocene deposits of St. Erth (*loc. cit.*, p. 142) Mr. A. Bell described provisionally two species as *N. Jani*, Mayer, 1873, and *N. Perrieriæ*, Bellardi, 1882, stating that they might be found eventually to be varieties of the Miocene form, *N. granifera* (*turonica*). An examination of the St. Erth fossils now in the British Museum (Nat. Hist.) shows this view, I think, to be correct. Comparing them with a large number in my collection of this somewhat variable species from the Faluns of Touraine, I find an equivalent of each of the specimens in question, and I have therefore now figured them as varieties of Deshayes' shell.

Sub-genus **AMYCLA,** H. and A. Adams, 1853.

Nassa (Amycla) semistriata (Brocchi). Plate XXXIV, fig. 24.

1814. *Buccinum semistriatum*, Brocchi, Conch. foss. subap., vol. ii, p. 651, pl. xv, fig. 15.
1844. *Nassa semistriata*, James, Journ. Geol. Soc. Dublin, vol. iii, pp. 62, 66.
1873–5. *Nassa semistriata*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 300, no. 142, 1873; vol. v, p. 276, no. 49, 1874; vol. vi, p. 278, no. 275, 1875.

1870–1915. *Nassa semistriata,* A. Bell, Journ. de Conch., vol. xviii, p. 346, no. 209, 1870; Geol. Mag. vol. x, p. 452, 1873; Rep. Brit. Assoc. (Bath), p. 136, 1888; (Leeds), pp. 410, 423, 1890; *N.* (*Uzita*) *semistriata,* Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 142, 1898; Geol. Mag. [6], vol. ii, p. 168, 1915.

1878. *Nassa semistriata,* de Stefani e Pantanelli, Bull. Soc. Malac. Ital., vol. iv, p. 101.

1882. *Nassa semistriata,* Bellardi, Moll. Terr. Terz. Piem., pt. iii, p. 145, pl. ix, fig. 14.

1887. *Nassa semistriata,* Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, p. 131, pl. xxiii, figs. 16—25.

1890. *Nassa semistriata,* Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 219, no. 2801.

1890. *Nassa semistriata,* Carus, Prod. Faun. Medit., vol. ii, p. 398.

1892. *Nassa semistriata,* Locard, Coq. mar. Côtes de France, p. 82, fig. 69.

1901. *Zeuxis* (*Amycla*) *semistriata,* Cossmann, Ess. Paléoconch. compar., vol. iv, p. 211, pl. ix, fig. 17.

1907. *Nassa semistriata,* Scalia, Atti Accad Gioen. Sci. Nat. Catania [4], vol. xx, p. 35, no. 308.

1913. *Nassa* (*Amycla*) *semistriata,* Gignoux, Ann. Univ. Lyon, n. s. [1], vol. xxxvi, p. 510.

Specific Characters.—Shell small, sub-ovate; whorls 7, convex, the last tumid, much the largest, all without longitudinal costæ; the apical whorls smooth, the next two ornamented with fine inconspicuous transverse striæ, all the others but the last being without sculpture, except one prominent groove below the suture which occurs in all of them, the body-whorl having in addition some rather distant grooves on the lower part only, extending to the base; mouth large, sub-oval, angulate above; outer lip thin, gently curved, ridged within; inner lip forming a wide glaze on the pillar; pillar excavated; canal very short.

Dimensions.—L. 13 mm. B. 6 mm.

Distribution.—*Recent:* Mediterranean, West European.

Fossil: St. Erth.

Miocene, Lower Pliocene: Italy.

Upper Pliocene: Italy, Sicily.

Pleistocene: Tuscany, Calabria, Sicily.

Remarks.—This species is unknown to me from the Anglo-Belgian region, though an allied shell, *N. labiosa,* is common in the Waltonian Crag, especially at Oakley. It was reported from Wexford by Sir H. James and Prof. Forbes,[1] but whether the typical *N. semistriata* occurs there seems to me doubtful; the original specimen cannot now be traced.

Bellardi described several other forms of this group as specifically distinct, under the names, for example, of *N. italica*, *N. Edwardsi*, *N. Hoernesi*, and *N. gigantula*, some of them having longitudinal costæ on the upper whorls while others are spirally grooved throughout. He lays special emphasis, however, on the partly striated character of what he regards as the true *N. semistriata.*

The shell here figured under that name is from the Lower Pliocene (*argiles bleues*) of the Ligurian coast; it is the short, partly striated, typical *N. semistriata* of Brocchi and Bellardi, and may be useful for comparison with any examples of

[1] Possibly this was *N. labiosa,* a specimen of which has been found recently in the Wexford gravels.

this group that may be found hereafter in our British deposits; an imperfect specimen of *N. semistriata*, now in the British Museum, has been obtained at St. Erth by Mr. Bell.

By H. and A. Adams *Amycla* was used for a separate genus allied to *Columbella*. By some authorities, including P. Fischer, it has been regarded as a sub-genus of *Nassa*. M. Cossmann, however, figures the present species as *Zeuxis* (*Amycla*) *semistriata* and as the typical form of this group of the mollusca.

Nassa (Amycla) labiosa (J. Sowerby). Plate XXXIV, figs. 20, 21.

1825. *Buccinum labiosum*, J. Sowerby, Min. Conch., vol. v, p. 122, pl. ccccLxxvii, fig. 3.

1842–74. *Nassa labiosa*, S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix, p. 540, 1842; Mon. Crag Moll., pt. i, p. 28, pl. iii, fig. 8; pl. vii, fig. 22, 1848; 1st Suppl., pt. i, p. 15, 1872; pt. ii, p. 176, 1874.

1843–81. *Buccinum labiosum*, Nyst, Coq. foss. Terr. Tert Belg., p. 577, no. 495, pl. xliii, fig. 14, 1843; *Nassa labiosa*, Conch. Terr. tert. Belg., p. 31, pl. ii, fig. 13, 1881.

1854. *Buccinum labiosum*, Beyrich, Zeitschr. Deutsch. Geol. Gesell., vol. vi, p. 462, pl. viii, fig. 5.

1871. *Nassa semistriata*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, pp. 144, 489.

1872. *Nassa labiosa*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 203, 208, 213.

1874–92. *Nassa semistriata*, var. *labiosa*, Van den Broeck, Ann. Soc. Malac. Belg. (Mémoires), vol. ix, pp. 120, 135; *N. labiosa*, vol. ix, pp. 260, 266, 272, 280, 285, 1874; vol. xiv, p. 74, 1879; vol. xvii, pp. 202, 204, 1882; vol. xix, pp. 9, 18, 1884; Bull. Soc. Belg. Géol. (Mémoires), vol. vi, pp. 121, 132, 147, 1892.

1890. *Nassa labiosa*, C. Reid, Plioc. Dep. Brit., p. 248.

1912. *Nassa labiosa*, Tesch, Med. v. d. Rijks. v. Delfstoffen, no. iv, p. 80, no. 198.

1914. *Nassa labiosa*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 72.

Specific Characters.—Shell small, ovate; spire elongato-conical; whorls 6—7; but little convex, rounded and slightly excavated at the base; ornamented by fine, regularly-spaced, rather deeply-cut sulci, about 16 to 18 on the last whorl; suture slight, canaliculated; mouth ovate, angulate above, rounded below; outer lip thin, denticulate; inner lip forming a wide glaze on the pillar; canal very short.

Dimensions.—L. 16 mm. B. 8 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Gedgrave, Sutton, Boyton. Waltonian: Walton-on-Naze, Beaumont, Little Oakley. Newbournian and Butleyan: *passim*. Wexford gravels. Bolderien, Diestien, Scaldisien, Poederlien: Belgium. Scaldisien, Poederlien: Holland.

Pleistocene of Sicily: Ficarazzi.

Remarks.—*Nassa labiosa* was known to Wood from the Coralline and Newbournian horizons, though not as an abundant shell; indeed in 1874 (*op. cit.*, p. 176) he seemed inclined to think it might be derivative at the latter; more recent work, however, has shown it to be one of the most characteristic fossils of the Waltonian Crag. I have collected some hundreds of specimens of it at Oakley.

Jeffreys regarded it as identical with *N. semistriata*, but this view was not accepted by Wood, nor has it been by any subsequent English writer. It belongs to the same group, but differs both in form and sculpture from the partly-striated shell described above, which Bellardi considered the type of that species, approaching more nearly some other allied forms considered by that author to be specifically distinct.

N. labiosa has not been recorded under that name from any of the Pliocene or Pleistocene deposits of the Mediterranean region, but in 1903, when visiting Sicily, I found at Ficarazzi, near Palermo, a number of fossils which, as stated on p. 73 of the present work, I was unable to separate from it; one of these I have now figured (Pl. XXXIV, fig. 20) with a similar specimen from Oakley. They are not partly striated as in the typical *N. semistriata*, but are covered with spiral striæ from the base to the upper whorls.

N. labiosa is first recorded from the Belgian Crag in the Bolderien (Miocene) deposits of Antwerp (*fide* Van den Broeck), and in England at the Coralline horizon; it is very common in the Waltonian, less so in the later Red Crag beds, and seems to have disappeared from these regions before the deposition of the Icenian.

It is not known from the Pleistocene of Great Britain, but if my identification of it with the Ficarazzi fossils is correct, it lingered on to Pleistocene times in the south of Europe.

Nassa (Amycla) gigantula (Bonelli MS.). Plate XXXIV, figs. 22, 23.

1825. *Buccinum gigantulum*, Bonelli, MS. Catal. Mus. Zool. Torino, no. 2919.
1882. *Nassa gigantula* and vars., Bellardi, Moll. Terr. Terz. Piem., pt. iii, p. 142, pl. ix, fig. 11.
1901. *Buccinum gigantulum*, Cossmann, Ess. Paléoconch. compar., vol. iv, p. 212.
1911. *Nassa semistriata*, var., Cerulli-Irelli, Palaeont. Ital., vol. xvii, p. 253, pl. xxiii, figs. 43—48.
1911. *Nassa totistriata*, Monterosato, MS.
1913–14. *Nassa semistriata*, var. *calabriensis*, Gignoux, Ann. Univ. Lyon, n.s. [1], vol. xxxvi, p. 512, pl. xv, fig. 7, 1913; *N. gigantula*, Bull. Soc. Géol. France [4], vol. xiv, pp. 329—334, 1914.

Specific Characters.—Shell much larger than the typical *N. semistriata*, ovato-conical, longitudinally ecostate; whorls convex, the last tumid, about half the total length, excavated below; ornamented throughout by flattened, closely-set spiral ridges, finer on the upper whorls; suture narrow, channelled; mouth oval, angulate above; outer lip rounded, grooved within; inner lip forming a wide glaze upon the pillar; pillar excavated in the middle; canal wide, short, notched, turning to the left.

Dimensions.—L. 20 mm. B. 10 mm.

Distribution.—Not recorded living.

Fossil: Wexford gravels.

Upper Miocene: Colli tortonesi, St. Agata.

Lower Pliocene: Vezza, Albenga

Upper Pliocene: Monte Mario, Teramo, Gravina, Imola, Girgenti, Porto Empedocle, Terranuova.

Pleistocene: Ficarazzi, Militello, Caltagirone.

Remarks.—The imperfect but unworn Wexford fossil now figured corresponds with a specimen I obtained in 1903 at Ficarazzi and with some others received from the Marchese di Monterosato as an undescribed species, *N. totistriata*, which, however, he now identifies with *N. gigantula*; as to the latter, Bellardi stated it to be ecostate and spirally striated throughout.

Dr. Gignoux (*loc. cit.*) figures a shell from the Calabrien deposits of Gravina as *N. semistriata*, var. *calabriensis*, which appears to correspond closely with the present form, but he also mentions *N. gigantula* as distinct although very near to *N. semistriata*. M. Cossmann also quotes the former as a recognised Pliocene species.

Sign. Cerulli-Irelli, on the contrary, dealing with a number of specimens from Monte Mario, some of which seem to be near to those here figured as *N. gigantula*, groups them all as varieties of *N. semistriata*. *N. gigantula*, however, appears to me to be more nearly related to the well-established Crag species *N. labiosa* than to the latter. As far as the Crag is concerned, therefore, I prefer to regard the three forms *N. labiosa*, *N. gigantula* and *N. semistriata* as specifically distinct. As to the typical *N. semistriata* I doubt, as already stated, whether it has been found in any British deposit, except at St. Erth.

Nassa (Amycla) Edwardsi (Fischer). Plate V, figs. 22, 23; Plate XXXIV, fig. 15.

1899. *Nassa Edwardsi*, Locard, Coq. mar. au large des Côtes de France, p. 51.

1901–7. *Nassa Edwardsi*, Scalia, Atti Accad. Gioen. Sci. Nat. Catania (4*a*), vol. xiv, p. 14, no. 171, 1901; vol. xx, p. 35, no. 307, 1907.

1913. *Nassa semistriata*, var. *Edwardsi*, Gignoux, Ann. Univ. Lyon, n.s. [1], vol. xxxvi, p. 513, pl. xv, figs. 8, 9.

1914. *Nassa Edwardsi*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 86, pl. v, figs. 22, 23.

Distribution (additional).—*Recent:* Portuguese coast, 370—820 m.

Fossil: Coralline Crag: Boyton.

Pleistocene: sub-Etnaen beds: Nizzeti and elsewhere.

Remarks.—The Crag shell figured in Pl. V, fig. 22, under this name, though the best I could lay my hand on at the time, was not very satisfactory. I have now obtained another specimen from the Sedgwick Museum at Cambridge which better represents, I think, the species in question.

Genus **DESMOULEA,** Gray (*continued from p. 89*).

Desmoulea conglobata (Brocchi). Plate XXXIV, fig. 27.

1890. *Nassa conglobata,* C. Reid, Plioc. Dep. Brit., pp. 13, 247.
1914. *Desmoulea conglobata,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 89.
1917. *Desmoulea conglobata,* A. Bell, Geol. Mag. [6], vol. iv, p. 412.

Distribution (additional).—

Fossil: Boxstone fauna. Coralline Crag: Gedgrave. Isle of Man.

Remarks.—To the localities for this shell given on p. 89 may be added the Gomer pit of Coralline Crag at Gedgrave. The specimen here figured was found by me some years ago at Beaumont, a locality at which, by the kindness of the late A. H. Stanford, Esq., of Beaumont Hall, I was able to spend, very profitably, several weeks. If the section is still open, it may be recommended as a promising spot for collectors, as the famous pit of Waltonian Crag at Oakley is not generally accessible. Owing to a mistake in the identification of several species, wrongly supposed to be arctic, the Beaumont fauna was for many years regarded as belonging to the latest division of the Red Crag.[1] It is, however, characteristically and undoubtedly Waltonian, possibly intermediate between Walton and Oakley.

The genus *Desmoulea*, formerly included with *Nassa*, belongs to a southern type found in the Miocene and Pliocene deposits of Italy and Sicily, and recent on the coasts of Africa.

D. conglobata is exceedingly rare in the English Crag, but has been recorded as a "Boxstone" fossil. There is a specimen of it, from the Coralline Crag, in the Sedgwick Museum at Cambridge, and Mr. Bell has recognised another, imperfect, from the Manxland Drift, in the Strickland collection at the same place.

Genus **BUCCINUM,** Linné (*continued from p. 115*).

Buccinum undatum, var. **pulchra,** F. W. Harmer. Plate X, fig. 13; Plate XXXV, fig. 3; Plate XLIV, figs 17, 18.

1914. *Buccinum undatum,* var. *pulchra,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 96, pl. x, fig. 13.

Dimensions.—L. 35—40 mm. B. 20—25 mm.

Distribution.—*Fossil:* (additional) Wexford gravels.

Remarks.—Although the coarsely sculptured *Buccinum undatum* of our British coasts, including the short spired var. *littoralis*, occurs at Wexford, the form most common at that locality is thin, delicate and translucent, with finer sculpture than

[1] Quart. Journ. Geol. Soc., vol. lvi, p. 715.

the type, sometimes finer than the specimens already figured. They approach the one given by me in 1914 as var. *pulchra*. Being fragile they are rarely found perfect.

In contrast to this, some of the Wexford fossils, *e. g. Purpura lapillus*, are abnormally thick and clumsy.

The variety *littoralis* of *B. undatum* occurs in the Pleistocene beds of Kelsey Hill, and the variety *striata* in the Wexford gravels.

Var. **minima,** F. W. Harmer. Plate VII, fig. 6.

1914. *Buccinum undatum,* var. *minima,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 97, pl. vii, fig. 6.

Remarks.—I have found a specimen among the Wexford stuff corresponding with the one from Oakley described under the above name on p. 97, both in size and in its fine and numerous costæ. It appears to be full grown.

Buccinum finmarchianum, Verkrüzen. Plate VIII, fig. 3; Plate XXXV, fig. 2.

1911. *Buccinum finmarkianum,* Sykes, Proc. Malac. Soc., vol. ix, p. 341.
1914. *Buccinum finmarchianum,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 101, pl. viii, fig. 3.

Distribution.—Fossil: Wexford (additional).

Remarks.—The imperfect fossil here given, one of two or three obtained from Wexford, corresponds so far as it goes with an example of a smooth variety of *B. finmarchianum* from the North Atlantic which Dr. Nordmann was kind enough to send me some time since, and with one of the specimens of that species figured as typical in Prof. G. O. Sars' well-known work (*op. cit.*, pl. xiii, fig. 10) often quoted in these pages. Our shell has a smooth polished surface showing obscurely the lines of growth and its fine, nearly obliterated spiral sculpture.

Genus **PURPURA,** Adanson (*continued from p.* 120).

Purpura lapillus (Linné) and vars. Plate XI, figs. 1—5, 7—12, 14—17,19—23.

1846. *Purpura lapillus,* E. Forbes, Mem. Geol. Surv., vol. i, p. 427.
1888–90. *Purpura lapillus,* A. Bell, Rep. Brit. Assoc. (Bath), pp. 135, 138, 1888; (Leeds), pp. 413, 414, 417, 419, 420, 1890.
1914. *Purpura lapillus,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 117.

Var. **menapiæ,** nov. Plate XXXIV, figs. 29, 30.

Remarks.—Specimens of *Purpura* from Wexford, where this variety is very abundant, are, like many of the fossils from that locality, thick and clumsy; they

are strongly ridged, the mouth having a thickened outer lip and generally tuberculated within. Fig. 31, from the Isle of Man, on the contrary, resembles some of those from the Crag, especially from the Butleyan and Icenian zones, in which the lip is but little thickened. As to this Dr. A. W. Cooke informs me that the toothed condition occurs in specimens in his collection from Portugal, and is a common though not a universal feature in British shells, but it is not found, so far as his experience goes, in Purpuras from the Kola fiord or the Murman coast of Russian Lapland, which are thin in texture; moreover, that a similar non-tuberculated form is met with in Iceland, the modification in shape and texture being due, he thinks, to its northern situation. He considers that, as a general rule, the toothed lip occurs in stout, compact, low-spired forms of *P. lapillus*, while shells with an elongated spire have usually a simple labrum.

Var. **minor**, Jeffreys (?). Plate XXXIV, fig. 33.

1867. *Purpura lapillus*, var. *minor*, Jeffreys, Brit. Conch., vol. iv, p. 277.

Dimensions.—L. 18—22 mm. B. 12—15 mm.

Remarks.—The specimen figured under this name represents a dwarf form not uncommon in the Wexford gravels which may possibly be the var. *minor* of Jeffreys. The latter, he says, is smaller than the type, more strongly ridged, and has a shorter spire. Among the Wexford Purpuras some may be noticed corresponding in sculpture with that figured on Pl. XI, fig. 5 as variety *brevis* (see Pl. XXXIV, fig. 32).

Var. **ventricosa,** nov. Plate XXXIV, fig. 34.

Dimensions.—L. 33 mm. B. 24 mm.

Distribution.—*Fossil:* Icenian Crag: Bramerton.

Remarks.—This is an unusual and, so far as I know, an unrecorded variety of *P. lapillus* from the Icenian Crag in the Wood collection at the Norwich Castle Museum.

Var. **incrassata** (J. Sowerby). Plate XI, fig. 1; Plate XXXV, fig. 1.

1914. *Purpura lapillus*, var. *incrassata*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 117, pl. xi, fig. 1.

Distribution.—*Fossil:* Coralline Crag: Boyton. Red Crag: *passim.* Icenian: Thorpe (Norwich). Wexford. Pleistocene: Middle Glacial, Kelsey Hill.

Remarks.—On Plate XI of the present Memoir I published three figures of

Purpura lapillus showing that the Crag varieties *incrassata* (fig. 1), *imbricata* (fig. 3), and *carinata* (fig. 4) differed only in size and in the imbrication of one of them. The fossil now figured from the York Museum presents another connecting link, being an imbricated example of the variety *incrassata;* it supports the view taken on p. 119, that imbrication is not a varietal character.

Purpura tetragona (J. Sowerby).

1914. *Purpura tetragona,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 116, pl. xi, fig. 6.

Var. **intermedia,** S. V. Wood. Plate XXXIV, fig. 28.

1848. *Purpura tetragona,* var. *intermedia,* S. V. Wood, Mon. Crag Moll., pt. i, pl. iv, fig. 7*c*.
1885. *Purpura tetragona,* Lorié, Arch. Mus. Teyler [2], vol. ii, p. 201, pl. vii, fig. 24.

Remarks.—The fossil here represented, from the Ipswich Museum, is a well-marked variety of *P. tetragona*, agreeing more or less nearly with the var. *intermedia* of Wood.

Dr. Lorié gives a figure of this variety from the Scaldisien of Holland, obtained at a depth of 52 metres from one of the Dutch borings at Goes.

Genus **PISANIA,** Bivona, 1832.

Pisania exigua (Dujardin). Plate XXXV, figs. 22, 23; Plate XLIV, fig. 19.

1837. *Murex exiguus,* Dujardin, Mém. Soc. Géol. France, vol. ii, p. 296, pl. xix, fig. 2.
1872. *Murex insculptus* (?), A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 209.
1874. *Murex insculptus,* S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. ii, p. 176, add. pl., fig. 9.
1884. *Murex (Muricopsis) exiguus,* Dollfus et Dautzenberg, Feuilles des jeunes Nat., vol. xvi, p. 104.
1890, *Murex insculptus,* C. Reid, Plioc. Dep. Brit., p. 247.

Specific Characters.—Shell small, solid, sub-fusiform; whorls 5, convex, the last two-thirds the total length; ornamented by strong, rounded, flexuous costæ, 8—12 on the body-whorl, crossed by rather coarse spiral ridges, with slight tuberculation at the points of contact, and finer ones in the interspaces; spire elongate, regularly tapering towards a blunt point; suture distinct, but not deep; mouth irregularly oval, angulate above, contracted at the commencement of the canal, which is short and open; outer lip thickened by the labial rib, denticulated within; umbilicus small; columella with a small tubercle.

Dimensions.—L. 10—12 mm. B. 5—6 mm.

Distribution.—Not known living.

Fossil: Waltonian Crag: Beaumont, Little Oakley. Newbournian: Waldringfield.

Miocene: Touraine.

Remarks.—In the concluding part of his 1st Supplement, Wood figured a shell from Waldringfield sent to him by R. Bell as *Murex insculptus.* It was considered by the latter to be identical with one he had received from Seguenza under that name.[1] Wood was unable to trace any reference to it, pointing out, however, that it resembled in some respects a Miocene species from Touraine, *Murex exiguus*, described by Dujardin, but that he was not satisfied it was the same.

I have lately sent a photograph of the Waldringfield fossil to my friend, M. Dautzenberg, who considers it belongs to the genus *Pisania*, and has kindly sent me some specimens of *P. exigua* for comparison. Except that our Crag shell is somewhat the larger and that its costæ are rather more numerous, the two seem to correspond.

I have also found a specimen of *P. exigua* in the Waltonian Crag at Beaumont. Neither it nor that from Waldringfield presents the appearance of being derivative; I am inclined to consider this species one of the survivors from Miocene seas of which we have so many instances in the Pliocene beds of East Anglia.

Genus **EUPLEURA,** H. and A. Adams, 1853.

Eupleura caudata (Say). Plate XXXV, fig. 24.

1822. *Ranella caudata,* Say, Journ. Acad. Nat. Sci. Philad. [1], vol. ii, p. 236.
1841–70. *Ranella caudata,* Gould, Inv. Mass., ed. 1, p. 297, fig. 204, 1841; ed. 2, p. 386, fig. 648, 1870.
1843. *Ranella caudata,* de Kay, Nat. Hist. New York [5], Mollusca, p. 139, pl. viii, fig. 176.
1865. *Ranella caudata,* Stimpson, Amer. Journ. Conch., vol. i, p. 58, pl. viii, fig. 5.
1903. *Eupleura caudata,* Cossmann, Ess. Paléoconch. compar., vol. v, p. 50.
1915. *Eupleura caudata,* Johnson, Bost. Soc. Nat. Hist., Occ. Papers, vol. vii; Fauna of New England, pt. xiii, p. 130.

Specific Characters.—Shell small, rhomboidal, solid; whorls 5, angulated above; ornamented by prominent longitudinal ribs, two of them spinous, stronger and more varicose than the others, and by fine equidistant spiral ridges; mouth ovate; outer lip varicose, angulated by the keel, strongly denticulated within; canal straight, narrow, rather long.

Dimensions.—L. 25 mm. B. 16 mm.

Distribution.—*Recent:* Coasts of Massachusetts and Connecticut, 1—8 fathoms.

Fossil: Pliocene: Florida, South Carolina. Pleistocene: Florida.

Remarks.—The term *Eupleura* was originally used by H. and A. Adams for a

[1] The term *Murex insculptus* had been previously used by Bellardi (in 1872) for a different shell from the Italian Miocene.

sub-genus of *Bursa* (*Ranella*) but has been more correctly grouped by M. Cossmann with the *Muricinæ*, the present species being taken as the type. It was first described as *Ranella caudata* but is now known to American conchologists under the above generic name.

The recent specimen here figured for comparison with our Crag shell I owe to the courtesy of Mr. C. W. Johnson of the Boston Society of Natural History. He informs me that *E. caudata* is a variable species, the northern and southern forms differing considerably, certain named varieties being found also on the gulf coast of Florida and the west coast of Mexico. As a fossil it occurs in the Pliocene of Florida and South Carolina, while an allied species, *E. miocenica* is reported doubtfully from the Miocene of North Florida.

Var. **Crowfootii** (S. V. Wood). Plate XXXV, fig. 25.

1879. *Murex Crowfootii,* S. V. Wood, Mon. Crag Moll., 2nd Suppl., p. 15, pl. i, fig. 15.
1890. *Murex Crowfootii,* C. Reid, Plioc. Dep. Brit., p. 247.

Varietal Characters.—Resembling generally the type form but being smaller, more slender in form, with a short spire and somewhat fewer costæ.

Dimensions.—L. 12 mm. B. 5 mm.

Distribution.—*Fossil:* Coralline Crag: Boyton. Waltonian: Little Oakley.

Remarks.—The specimen figured under the above name is the one found at Boyton by Mr. Crowfoot, one of the last three survivors of Wood's coadjutors. It was considered by the latter as a new and distinct form and was very appropriately named by him after its discoverer. I have since obtained another example of the same kind at Oakley.

It must be admitted that our fossils present a suspicious resemblance to the figure of the American *Ranella caudata* given by Gould (*op. cit.*) referred to in the last paragraph, a view which a comparison with Mr. Johnson's shell supports, Although not absolutely identical, we may regard them, I think without hesitation. as a variety of that species.[1] With this my good friend Mr. Dollfus agrees, suggesting they should retain Wood's name of *Crowfootii* as varietal. I am glad in this way to keep alive the memory not only of the discovery of this little fossil by my old colleague but also generally his connection with Crag work.

The occasional occurrence of certain American forms in our Pliocene and Pleistocene deposits is interesting, pointing possibly to the existence in former times of westerly currents more or less similar to those which are now prevalent.

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[1] Gould's figure of *R. caudata* (*op. cit.*) is more slender than Mr. Johnson's specimen, resembling still more nearly our Crag fossils.

Genus **MUREX,** Linné (*continued from p.* 124).

Murex recticanalis, S. V. Wood.

1879. *Murex recticanalis*, S. V. Wood, Mon. Crag Moll., 2nd Suppl., p. 15, pl. i, fig. 7.
1890. *Murex recticanalis*, C. Reid, Plioc. Dep. Brit., p. 247.

Specific Characters.—Shell small, fragile, fusiform, turreted; whorls 5 or 6, convex, squarely angulate above, with a shelf below the suture; ornamented by longitudinal costæ with rounded or sub-spinous points where they cross the keel, clathrated by well-marked spiral ridges; spire short, rapidly diminishing in size upwards; suture wide and deep; mouth ovate, obtusely angulated by the keel; canal fairly long, open.

Dimensions.—L. 12 mm. B. 6 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Sutton.

Remarks.—M. Dollfus has expressed a doubt whether the specimen figured by Wood under this name can be satisfactorily referred to the genus *Murex*, suggesting it may be a *Trophon* or possibly a *Fusus*. It was originally described from an imperfect but not waterworn example from the Coralline Crag of Sutton. There is another, perfect, in the Sedgwick Museum at Cambridge, labelled *M. recticanalis*, Newbourn, but it is not the same as Wood's shell. I retain provisionally his generic name for the Sutton fossil.

Sub-genus **PTEROPURPURA,** Jousseaume, 1879.

Murex (Pteropurpura) boytonensis (F. W. Harmer). Plate XII, fig. 8; Plate XXXV, fig. 21.

1914. *Ocinebra tortuosa*, var. *boytonensis*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 125, pl. xii, fig. 8.

Specific Characters.—Shell large and solid, ovato-turreted, with a pyramidal spire; whorls 6, the last much the largest, rapidly diminishing in size towards a rounded apex; coarsely ornamented by three thin projecting wing-like varices, continuous across the suture, connecting the whorls, and by well-marked, rather distant transverse ridges reaching the base of the shell, the upper one on each whorl forming an indistinct angulation with a sloping shelf below the suture; mouth pyriform, contracted at the commencement of the canal; canal short, open, narrow; outer lip thickened, expanded, so as to form a triangular space at the base; inner lip large, detached below.

Dimensions.—L. 52 mm. B. 28 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Boyton.

Remarks.—On Plate XII, fig. 8, I figured a specimen which came to me from the Ipswich Museum as *Murex tortuosus*, a name which I adopted for it without sufficient consideration. I now think not only that it has no connection with that species, but that it belongs to another group of the Muricidæ, the sub-genus *Pteropurpura*, Jousseaume (*Pteronotus*, Swainson), distinguished by its three wing-like varices and other characters which separate it from the *Ocinebra tortuosa* of the Crag. Since then, moreover, I have received a specimen from the York Museum, obtained at Boyton, which seems to be the same. These shells belong to a group from the Miocene of the Vienna basin, figured by Hörnes (Foss. Moll. Tert. Wien, vol. i, p. 249, pl. xxv, figs. 11—16), one of them being erroneously identified with *Murex tortuosus*, which, as stated on p. 125, is not typical of the Crag species. One side of the present fossil, the back, shows very clearly its form and sculpture, the other side, that of the mouth, being covered by a growth of *Hydractinia;* fortunately that portion of the shell is well exposed in the one before figured (Pl. XII, fig. 8). In the latter, however, the wing-like varices are not so well preserved. I retain the name *boytonensis* as specific (used before as varietal) for the present form.

Sub-genus **ALIPURPURA**, Bayle, 1884.

Murex (Alipurpura) elegantula, sp. nov. Plate XXXV, fig. 20.

Specific Characters.—Allied to the sub-genus and to the shell last described, but differing in size, sculpture, general appearance, and especially in the non-continuous character of the varices which end in well-marked and spiny projections; it is a slender and delicate shell ornamented by numerous spiral ridges and exceedingly fine longitudinal lines; mouth pyriform, contracted where it joins the canal, which is rather long, semitubular and nearly closed; outer lip crenulated, with a strong triangular sinus above corresponding with the spine which terminates the varicose rib; columella large, smooth, detached from the canal.

Dimensions.—L. 29 mm. B. 15 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Boyton.

Remarks.—The name *Alipurpura* is used by M. Cossmann for a sub-genus of *Murex*, a group of shells closely allied to *Pteropurpura* (*Pteronotus*) in which the varices are discontinuous, ending in a spiny point. It ranges as a fossil from the Eocene to the Pliocene, and is recorded also as a recent genus.

The specimen here figured under the above specific name is also from the

Coralline Crag of Boyton, and belongs to the York Museum. It presents no appearance of derivation, as might be expected in a fossil from that horizon, and is, I believe, a genuine Crag shell. In form and sculpture it resembles a recent Australian species, *Pteropurpura triformis*, an example of which I have received from my friend, M. Dautzenberg. In that shell, however, which is considerably larger, the varices are continuous. The latter, moreover, is not unlike an Oligocene form, *Murex tristichus*, Beyrich,[1] which is figured by Dr. Ravn under that name.[2] This also appears to belong to the *Pteropurpura* group.

Genus **OCINEBRA**, Leach (*continued from p.* 125).

Ocinebra erinacea (Linné). Plate XII, figs. 12—14; Plate XXXV, fig. 17.

1846. *Murex erinaceus*, Lovén, K. Svensk. Vet. Akad. Förh., vol. iii, p. 86.
1864. *Murex erinaceus*, S. P. Woodward in White's Hist. of Norfolk, ed. 3, p. 117.
1871–92. *Murex erinaceus*, A. Bell, Geol. Mag., vol. viii, p. 453, 1871; Rep. Brit. Assoc. (Bath), p. 135, 1888; (Leeds), pp. 412, 414, 417, 420, 1890; Proc. Roy. Phys. Soc. Edinb., vol. xii, p. 26, 1892; Rep. Yorks. Phil. Soc., pp. 63, 70, 71, 73, 1892.
1872. *Murex erinaceus*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 213.
1872–1914. *Murex erinaceus*, F. W. Harmer, Trans. Norf. Norw. Nat. Soc., vol. i, pt. 3, p. 46, 1872; *Ocinebra erinacea*, Plioc. Moll. Gt. Brit., pt. i, p. 124, pl. xii, figs. 12-14, 1914.
1874. *Murex erinaceus*, Darbishire, Quart. Journ. Geol. Soc., vol. xxx, p. 40.
1890. *Murex erinaceus*, C. Reid, Plioc. Dep. Brit., p. 247.

Distribution.—Fossil: (additional) Worden, Largo Bay, Wexford, Balbriggan Bay, Belfast (Boulder clay), Estuarine clays of N. E. Ireland. Holocene: Portrush.

Remarks.—This common and recent British species is very rare in the East Anglian Crag, but is widely diffused in our British Pleistocene deposits, having been recorded also from many such localities in Ireland. I have recently received a number of specimens from Father Codd found by him in the Wexford gravels, one of which I now figure. They are generally shorter in the spire than those now found on our coasts. Their occurrence at Wexford is interesting. As a British fossil the distribution of *O. erinacea* is characteristically Pleistocene rather than Pliocene; it is one of the species which give to the greater part of the molluscan fauna of Wexford a comparatively recent character. Although it occurs in some of our glacial deposits, its distribution is southern rather than northern. Its most northern range as recent seems to be the Cattegat (Lovén). It has not been recorded as a fossil from the Christiania fiord or any other northern locality.

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[1] Zeitschr. Deutsch. Geol. Gesell., vol. vi, p. 746, pl. xvi, fig. 1, 1854.
[2] K. Danske, Vid. Selsk. Skrift. [7], vol. iii, p. 318, pl. v, fig. 10, 1907.

Ocinebra tortuosa (J. Sowerby). Plate XXXV, figs. 7, 8.

1825. *Murex tortuosus*, J. Sowerby, Min. Conch., vol. v, p. 48, pl. ccccxxxiv, fig. 2.

1842–8. *Murex tortuosus*, S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix, p. 540, 1842: Mon. Crag Moll., pt. i, p. 40, pl. iv, fig. 9, 1848.

1843–81. *Murex tortuosus*, Nyst, Coq. foss. Belg., p. 545, pl. xli, fig. 14, 1843; Conch. Terr. tert. Belg., p. 3, pl. i, fig. 1, 1881.

1871. *Murex erinaceus*, var., Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 489.

1872. *Murex tortuosus*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 209, 213.

1890. *Murex tortuosus*, C. Reid, Plioc. Dep. Brit., p. 247.

1892. *Murex tortuosus*, Van den Broeck, Bull. Soc. Belge Géol., vol. vi (Mémoires), p. 131.

1914. *Ocinebra tortuosa*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 125.

Specific Characters.—Shell fusiform, rugged and solid; whorls 6, convex, angulated, with a sloping shelf below the suture, the last two-thirds the total length; ornamented by well-marked spiral ridges and on the upper whorls by flattened and conspicuous longitudinal costæ which are nodulous on the keel and generally disappear towards the base of the shell, also by three strong and prominent varices, oblique, tortuous or fimbriated, which cross both the shelf and the suture and are specially developed on the body-whorl; spire rather short, turreted, regularly diminishing in size towards a blunt apex; suture wide and deep; mouth inequilateral; outer lip angulated by the keel, with a wide expanded margin, thickened by the labial varix and strengthened outside by the spiral ridges, denticulated within; canal narrow, open, contracted, turning slightly to the left.

Dimensions.—L. 34—40 mm. B. 15—20 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Orford, Sutton, Ramsholt, Boyton. Waltonian: Walton-on-Naze, Beaumont, Little Oakley. Newbournian: Waldringfield, Newbourn, Sutton, Ramsholt, Shottisham, Felixstow. Butleyan: Butley. Icenian: Bramerton. Scaldisien, Poederlien: Belgium.

Remarks.—On p. 125, while calling attention to an imperfect specimen which I then thought might be regarded as a variety of *O. tortuosa*, I alluded incidentally to that species, but a further study of the group to which it belongs suggests the desirability of dealing more fully with this subject.

In the non-photographic figures given by Wood in 1848 and by Nyst in 1881 (*op. cit.*) the artists have not represented very accurately what seems to me its typical forms as represented by specimens in my collection, either from the Coralline Crag or from Oakley. In these the sculpture is mainly spiral on the lower whorls, which are generally ornamented only by three prominent and oblique varices, becoming spiny or nodulous on the keel. On the upper whorls there are usually some small supplementary longitudinal costæ which give that part of the

shell a clathrated appearance. In the variety for which I propose the name *clathrata* (figs. 10 and 14) these costæ are strengthened and extend to the body-whorl, giving the whole shell a reticulate sculpture.

This variety (*clathrata*), however, is less common that that shown in figs. 7, 8, which I consider more typical.

O. tortuosa is fairly abundant at Oakley, where I have obtained a considerable number of specimens, but it seems to be less so in the Coralline or in the later zones of the Red Crag, though generally present there.

According to Nyst and Van den Broeck it is rare in the Belgian Pliocene.

Jeffreys regarded *O. tortuosa* as a variety of *O. erinacea*, a view which Nyst appeared inclined to support. I follow Wood, however, in considering them specifically distinct, the former being an extinct and characteristic Waltonian fossil, the latter a recent and a pre-eminently Pleistocene shell.

The various forms of *Ocinebra* described in the following paragraphs have, more or less, a family likeness to *O. tortuosa.* They are each distinguished, however, by certain features by which they may be identified without much difficulty. I think it desirable, therefore, to retain the names by which they have been hitherto known, figuring specimens of them together on the same plate, that students may the more easily appreciate the grounds on which Wood regarded them as specifically distinct.

Var. **minor**, F. W. Harmer. Plate XII, figs. 9—11; Plate XXXV, fig. 9.

1914. *Ocinebra tortuosa*, var. *minor*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 125, pl. xii, figs. 9—11.

Remarks.—This specimen is from Oakley; it is a somewhat more delicate shell than any of the varieties of *O. tortuosa* already figured.

Ocinebra pseudo-Nystii (S. V. Wood). Plate XXXV, fig. 12.

1879. *Murex pseudo-Nystii*, S. V. Wood, Mon. Crag Moll., 2nd Suppl., p. 14, pl. i, fig. 8.
1890. *Murex pseudo-Nystii*, C. Reid, Plioc. Dep. Brit., p. 247.

Specific Characters.—Shell of moderate size, strong, sub-fusiform; whorls 7, convex, not strongly angulate above, the last about two-thirds the total length; ornamented by 8—9 varices, thin, lamellate and compressed, more or less equal in size, not spinous, and by well-marked and flexuous spiral ridges; spire elevated, gradually diminishing upwards to a blunt point; suture fairly deep; mouth ovate with a distinct and narrow canal; outer lip indistinctly denticulate within.

Dimensions.—L. 24 mm. B. 12 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Boyton.

Remarks.—This shell was originally described by Wood from a Coralline Crag fossil obtained at Boyton. There are two examples of it, one being now figured, at the British Museum (Nat. Hist.), which have been labelled *Murex Canhami.* Wood's type specimen of the latter, however, came from the Newbournian Crag of Waldringfield. It is much smaller, differing from the present species both in form and sculpture.

Wood states that he had compared his type fossil with specimens of *M. Nystii* from the Miocene of Belgium, but that although they approach in certain respects they are not the same.

There is an example of the latter in the Norwich Museum which bears out Wood's opinion.

Var. **similis,** nov. Plate XXXV, fig. 13.

Varietal Characters.—Agrees generally with the type form of *O. pseudo-Nystii,* but is larger, the sculpture is coarser and the varices are more distinct.

Dimensions.—L. 30 mm. B. 16 mm.

Distribution.—Not known living.

Fossil: Waltonian Crag: Little Oakley.

Remarks.—I have two or three specimens of this variety in my collection from Oakley. It seems to be an intermediate form connecting *O. pseudo-Nystii* and *O. tortuosa.*

Ocinebra Reedii (S. V. Wood). Plate XXXV, fig. 11.

1879. *Murex Reedii,* S. V. Wood, Mon. Crag Moll., 2nd Suppl., p. 13, pl. i, fig. 9.
1890. *Murex Reedii,* C. Reid, Plioc. Dep. Brit., p. 247.

Specific Characters.—Shell fairly large, thick, fusiform; spire elevated with an acute apex; whorls 7, sub-angulate, the last much the largest; varices thin, foliaceous, with projecting spines on the angulated part of the whorls, distant on the last, closer and more numerous on the upper ones; spiral sculpture wanting or obsolete; mouth oval; outer lip thickened by the labial varix, denticulated within; canal rather long, narrow, oblique, nearly closed; columella flexuous.

Dimensions.—L. 40 mm. B. 20 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Boyton. Waltonian: Walton-on-Naze, Little Oakley. Butleyan: Butley (Kennard).

Remarks.—This species was known to Wood from a unique specimen obtained

at Boyton forty years ago, which is now in the York Museum. It seems to be closely related to *O. tortuosa*, but, as he pointed out, it shows no trace of the coarse spiral sculpture characteristic of the latter species, which even in the many water-worn fossils I have found at Oakley hardly ever fails to be apparent. The Boyton specimen, on the contrary, evidently I think from the Coralline Crag, is quite unworn. I have one or two others, imperfect, in my collection from Oakley.

Ocinebra Canhami (S. V. Wood). Plate XXXV, figs. 15, 16.

1872. *Murex Canhami*, S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. i, p. 30, pl. vii, fig. 14.
1890. *Murex Canhami*, C. Reid, Plioc. Dep. Brit., p. 247.

Specific Characters.—Shell small, fragile, oblongo-ovate, fusiform; whorls 6, depressed and angulate above, the last much the largest, two-thirds the total length; spire scalariform, rapidly diminishing towards the apex; ornamented by strong, well-marked spiral ridges and by distant lamelliform varices which become spinous on the keel and cross the shelf between it and the suture; mouth oval; canal short; outer lip thickened by the labial varix, angulated by the keel, spinous above.

Dimensions.—L. 14 mm. B. 7 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Boyton. Waltonian: Walton-on-Naze, Little Oakley. Newbournian: Waldringfield, Newbourn.

Remarks.—Specimens of this form have been found at various localities in the Crag. They are small, delicate shells; always maintaining the same general character, unworn, and clearly showing the original sculpture. They offer no suggestion of being derivative. My figures convey a somewhat wrong impression as to their appearance, since they are drawn twice the real size.

One of the specimens now given is from the Coralline Crag of Boyton, another from the Newbournian Crag of Waldringfield, and I have found one or two others from the Waltonian of Oakley. I agree with Wood in thinking this small delicate species distinct from the thick coarsely sculptured *O. tortuosa* or from any of the allied forms of the Coralline or Red Crags.

The present species was named after the late Rev. H. Canham of Waldringfield, for many years a zealous collector of Crag fossils.

Ocinebra craticulata (Fabricius). Plate XXXVI, figs. 17—19.

1780. *Tritonium craticulatum*, Fabricius, Faun. Groenl., p. 400.
1848. *Tritonium (Trophon) craticulatum*, Middendorff, Mém. Acad. Imp. Sci. St. Petersb. [6], vol. vi, p. 452, pl. i, fig. 8.

1878. *Murex craticulatus*, Philippi, Martini und Chemnitz, Conch. Cab., ed. 2, vol. iii (Murex), p. 30, pl. xii, figs. 3, 4.

1880. *Trophon craticulatus*, Tryon and Pilsbury, Man. Conch., vol. ii, p. 139, pl. xxxi, figs. 309, 310.

1910. *Trophon craticulatus*, Odhner, Archiv Zool., K. Svensk. Vet.-Akad., vol. vii, no. 4, pp. 13, 24.

1914. *Trophon Fabricii*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 130.

Dimensions.—L. 35 mm. B. 18 mm.

Distribution.—*Fossil:* Wexford gravels (additional).

Remarks.—Considerable difference of opinion has existed as to the correct nomenclature, both generic and specific, of this shell. Originally described as a *Tritonium* by Fabricius and Middendorff, and afterwards by Reeve and Philippi as a *Murex*, it has been generally referred to the genus *Trophon.*

The specific name *craticulatus*, moreover, originally proposed by Fabricius, was altered by Jeffreys to *Fabricii*, Beck, on the ground that the former had been previously used by Linné for a *Murex* (*M. craticulatus*), which he said was really a *Trophon.*[1] The latter seems, however, to be a different species. At present our shell is usually known under the specific name of *craticulatus*, which I now adopt in place of the *Fabricii* of p. 130. M. Dollfus considers, however, and I think with reason, that it belongs to the genus *Ocinebra* rather than to *Trophon.*

The recent example of this form here represented (Pl. XXXVI, fig. 17) may be regarded as typical, corresponding generally with the figures of *Trophon craticulatum* given by Middendorff and Kobelt, and of *Murex borealis* by Reeve. It may be recognised by its thin, variciform and irregularly placed costæ, which cross the shelf below the suture obliquely, and by its rather distant spiral ridges extending as far as the keel but not to the shelf. I have obtained several imperfect specimens from Wexford which agree more or less nearly with the type (fig. 17) but are smaller in size.

Var. **reticulata,** nov. Plate XII, fig. 28; Plate XXXVI, figs. 20, 21.

1872. *Trophon craticulatus*, S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. i, p. 25, pl. iii, fig. 1.

1914. *Trophon Fabricii*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 130, pl. xii, fig. 28.

Varietal Characters.—Differs from the type in size, form and sculpture, being small and shorter in proportion; the sculpture is reticulate, the costæ and spiral ridges are nearly equal, the latter being more prominent and less numerous.

Dimensions.—L. 19 mm. B. 12 mm.

Distribution.—*Fossil:* Waltonian Crag: Little Oakley. Wexford, Bridlington.

Remarks.—The fossils here given may be regarded, I think, as a dwarf variety of *O. craticulata*, although a very distinct one. The Bridlington shell (fig. 20), which I refigure for the purpose of comparison, is that originally described by

[1] Ann. Mag. Nat. Hist. [4], vol. xix, p. 326.

Wood (*op. cit.*) under the present specific name. I have several specimens from Wexford, more or less imperfect, which appear to be the same, as may probably be my Pl. XII, fig. 28, obtained at Oakley.

Sub-genus **OCINEBRINA,** Jousseaume, 1879.

Ocinebra (Ocinebrina) aciculata (Lamarck). Plate XXXV, figs. 18, 19.

1822–43. *Murex aciculatus,* Lamarck, Anim. sans Vert., vol. vii, p. 176, 1822; ed. Desh., vol. ix, p. 600, 1843.
1836. *Murex corallinus,* Scacchi, Cat. Conch. Regn. Neap., p. 11, fig. 15.
1836–44. *Fusus lavatus,* Philippi, Enum. Moll. Sic., vol. i, p. 203, 1836; *Fusus corallinus,* vol. ii, p. 178, pl. xxv, fig. 29, 1844.
1853. *Murex corallinus,* Forbes and Hanley, Brit. Moll., vol. iii, p. 374, pl. cii, figs. 5, 6.
1867–71. *Murex aciculatus,* Jeffreys, Brit. Conch., vol. iv, p. 310, 1867; vol. v, p. 218, pl. lxxxiv, fig. 2, 1869; in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 144, 1871.
1870. *Murex corallinus,* A. Bell, Journ. de Conch., vol. xviii, p. 344, no. 163.
1872. *Murex aciculatus,* A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 203.
1872. *Murex corallinus,* S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. i, p. 30, pl. ii, fig. 12.
1873–5. *Murex aciculata,* Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 346, no. 185, 1873; vol. vi, p. 340, no. 365, 1875.
1882–98. *Murex (Corallinia) aciculatus,* Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 24, pl. ii, fig. 4, 1882; *M. (Ocinebrina) aciculatus,* vol. ii, p. 765, 1898.
1887. *Murex aciculatus,* Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, p. 20, pl. vi, figs. 2, 3.
1890. *Ocinebra aciculata,* Carus, Prod. Faun. Medit., vol. ii, p. 386.
1903. *Ocinebra (Ocinebrina) aciculata,* Cossmann, Ess. Paléoconch. compar., vol. v, p. 38.

Specific Characters.—Shell small, solid, oblong; whorls 7—8, convex, compressed upwards, the last two-thirds the total length; ornamented by strong, rounded, close-set, longitudinal ribs, occasionally varicose, and by rough wavy spiral ridges which cross the ribs; spire produced, regularly diminishing upwards to a fine rounded apex; suture wide, not deep; mouth oval, slightly expanded; outer lip thin, semicircular, scalloped within by the spiral ridges; inner lip folded on the pillar, detached at its lower edge; pillar broad and glossy; canal short, partly open, narrow.

Dimensions.—L. 9—12 mm. B. 5—6 mm.

Distribution.—Recent: Channel Islands. North Atlantic from Brittany to Madeira, the Canary Islands and the Azores. Mediterranean, Adriatic.

Fossil: Coralline Crag: Gedgrave. Waltonian: Walton-on-Naze, Beaumont, Little Oakley.

Pliocene: Biot, Legoli (Italy).

Pleistocene: Mte. Pellegrino, Reggio, San Giovanni, Valle Biaia.

Remarks.—This southern species has been known hitherto from the Coralline Crag only. I have found, however, a dozen specimens at Beaumont and Oakley,

and it is also recorded from Walton, supporting, with many other similar facts, the view I have taken that zoologically the Waltonian Crag is more nearly related to the Coralline than it is to the later horizons of the Red Crag.

It does not seem to have been widely diffused as a fossil, having been only reported from the Pliocene deposits of the continent, so far as I know, by Mr. A. Bell, from Biot near Antibes in 1870, by Seguenza, from Legoli in the Val d'Era in 1875, and by the latter authority from several localities in the Pleistocene of Italy and Sicily.

The sub-genus *Ocinebrina*, of which *O. aciculata* is taken as the type, is now used for a group of the genus *Ocinebra*, having numerous varices, neither lamellar nor foliaceous, a comparatively small mouth and a short canal.

Ocinebra (Ocinebrina) funiculosa (Borson). Plate XXXVI, figs. 1, 2.

1814. *Murex craticulatus*, var., Brocchi, Conch. foss. subap., vol. ii, p. 663, pl. xvi, fig. 3.
1821. *Murex funiculosus*, Borson, Mem. Accad. Sci. Torino, vol. xxvi, p. 304, pl. i, fig. 2.
1841. *Murex funiculosus*, Michelotti, Mon. *Murex*, p. 18, no. 24.
1868. *Murex funiculosus*, Foresti, Mem. Accad. Sci. Bologna [2], vol. vii, p. 555.
1872. *Murex funiculosus*, Bellardi, Moll. Terr. Terz. Piem., pt. i, p. 110.
1875. *Murex funiculosus*, Seguenza, Boll. R. Com. Geol. Ital., vol. vi, p. 340, no. 361.
1878. *Murex funiculosus*, de Stefani e Pantanelli, Bull. Soc. Malac. Ital., vol. iv, p. 92.
1890–1904. *Ocinebra funiculosa*, Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 243, no. 3362, 1890; *Murex* (*Ocinebrina*) *funiculosus*, Moll. Terr. Terz. Piem., pt. xxx, p. 23, pl. vi, figs. 26, 27.
1893–98. *Murex funiculosus*, A. Bell, Proc. Roy. Irish Acad. [3], vol. ii, p. 627, 1893; Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 138, 1898.
1903. *Ocinebra* (*Ocinebrina*) *funiculosa*, Cossmann, Ess. Paléoconch. compar., vol. v, p. 40.

Specific Characters.—Shell solid, fusiform, turreted; whorls 6, convex, the last tumid, much the largest, excavated below, depressed above; spire produced, regularly diminishing in size upwards; apex acute; suture deep; ornamented by 8 oblique or flexuous costæ, wide, strong and rounded, and by irregular wavy spiral ridges; mouth oval, angulate above and below; outer lip thickened by the labial rib, denticulated within; canal short, closed; umbilicus superficial.

Dimensions.—L. 30 mm. B. 16 mm.

Distribution.—Not known living.

Fossil: St. Erth.

Lower Pliocene: Piedmont, Tuscany.

Upper Pliocene: Asti, Bologna.

Remarks.—The specimen here figured was one of those obtained by S. V. Wood, Jr., from St. Erth, now in the British Museum (Nat. Hist.). It is said to be common in the Upper Pliocene of Asti, but has not been reported hitherto from the Anglo-Belgian basin.

I figure with the St. Erth fossil one I have received from my friend Prof. Issel

of Genoa, under the present name. They agree in sculpture and in their general character, but the latter is smaller, with the spire shorter and not so slender in proportion.

Genus **TROPHON**, Montfort (*continued from p.* 134).

Sub-genus **BOREOTROPHON**, P. Fischer, 1884.

Trophon (Boreotrophon) truncatus (Ström). Plate XII, figs. 23, 24; Plate XXXVI, figs. 22, 23.

1853. *Trophon clathratum*, Forbes and Hanley, Brit. Moll., vol. iii, p. 436, pl. cxi, figs. 1, 2.

1863. *Trophon truncatus*, Jeffreys, Rep. Brit. Assoc. (Newcastle-on-Tyne), p. 79.

1866. *Trophon truncatus*, Jamieson, Quart. Journ. Geol. Soc., vol. xxii, p. 279.

1888–93. *Trophon truncatus*, A. Bell, Rep. Brit. Assoc. (Bath), p. 136, 1888; (Leeds), p. 414, 1890; Proc. Roy. Phys. Soc., Edinb., vol. xii, p. 22, 1893.

1892. *Trophonopsis truncata*, Locard, Coq. mar. Côtes de France, p. 109.

1898. *Trophon truncatus*, Posselt, Medd. om Grønl., p. 175.

1910–15. *Trophon truncatus*, Odhner, Archiv. Zool., K. Svensk. Vet.-Akad., vol. vii, no. 4, pp. 13, 24, 1910; K. Svensk. Vet.-Akad. Handl., vol. liv, p. 178, 1915.

1914. *Trophon truncatus*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 129, pl. xii, figs. 23, 24.

1915. *Trophon truncatus*, Johnson, Boston Soc. Nat. Hist., Occ. Papers, vol. vii, Fauna of New Engl., pt. xiii, p. 131.

Distribution.—Recent: (additional) Faroes, Murman coast, Barents sea, arctic shores of Siberia.

Fossil: Newbournian Crag: Felixstow. Wexford. Pleistocene: Kelsea Hill, Bridlington, Caithness, Clyde beds, Belfast, Ballyrudder.

Remarks.—Much difference of opinion has existed as to the nomenclature of the shells known as *T. truncatus*, *T. bamffius* and *T. clathratus*, some authorities regarding them as varieties of one species, others as specifically distinct. As to *T. truncatus*, however, it is now generally agreed that the type form is a small shell with numerous fine costæ, represented, for example, by the recent specimen figured under that name by Jeffreys in the 'British Conchology' (vol. v, pl. lxxxiv, fig. 6). It is the *T. clathratus* of Gould.[1] With this form I group, as varieties, one of the specimens figured by Donovan as *T. Bamffius* (Brit. Shells, pl. clxix, fig. 1) with certain other multicostate and allied shells.

The typical *T. truncatus* occurs but rarely in the Crag; it is more common in our Pleistocene deposits, and is exceedingly abundant at Wexford. Out of some hundreds of Trophons received from that locality by far the larger number belong to this species and its varieties.

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[1] Rep. Invert. Mass., ed. 2, p. 377, fig. 643, 1870.

Although *T. truncatus* is found at present in British seas, its range is principally northern and arctic, extending from Spitzbergen and Barents sea to Greenland and thence to Canada and the New England coast. *T. clathratus*, which occurs with it as a fossil at Wexford, though not so abundantly as the former, is a Scandinavian and circumpolar species.

Var. **major** (Brøgger). Plate XXXVI, fig. 25.

1848. *Fusus Banffius*, Reeve, Conch. Icon., vol. iv (*Fusus*), pl. xxi, fig. 90 (in text), fig. 91 (on plate).
1872. *Trophon scalariformis*, juv., S. V. Wood, Mon. Crag Moll., 1st Suppl., p. 26, pl. iii, fig. 10; *T. Bamffius*, p. 26, pl. iii, fig. 11.
1901. *Trophon truncatus*, var. *major*, Brøgger, Norges geol. Undersøgelse, no. 31, p. 654, pl. v, fig. 11.

Varietal Characters.—Larger than the type but with similar sculpture, varying somewhat in size and form, having a short canal and sometimes an expanded mouth.

Dimensions.—L. 15—20 mm. B. 8—12 mm.

Distribution.—*Recent:* British and northern.

Fossil: Waltonian Crag: Little Oakley, probably elsewhere in Red Crag. Wexford, March, Bridlington, Clyde beds. Christiania fiord.

Remarks.—The Wexford specimen figured under this name corresponds with Prof. Brøgger's var. *major* from the Pleistocene of Christiania, and with those given by Wood from the Clyde beds and from March (*op. cit.*, figs. 10, 11). It is an enlarged form of *T. truncatus*, characteristic of northern seas, occurring also in our Pleistocene beds and very common at Wexford. M. Dautzenberg considers one of the specimens of *Murex Bamffius*, figured by Donovan, as equivalent to *M. clathratus*, Linné.

Var. **intermedia,** nov. Plate XXXVI, fig. 24.

Varietal Characters.—Larger than the type, and longer and more slender in the spire than the variety *major*. The longitudinal costæ are fine and numerous as in *T. truncatus*.

Dimensions.—L. 15 mm. B. 6 mm.

Distribution.—*Fossil:* Wexford.

Trophon (Boreotrophon) clathratus (Linné). Plate XII, fig. 25; Plate XXXVI, figs. 3—6.

1870. *Trophon clathratus*, S. V. Wood, Jr., Quart. Journ. Geol. Soc., vol. xxvi, p. 92.
1880. *Trophon clathratus*, Stewart, Proc. Belfast Nat. Field Club, Appendix, p. 175.
1898. *Trophon clathratus*, Posselt, Med. om Grønl., p. 176.

1901. *Trophon clathratus*, var. *major*, Brøgger, Norges geol. Undersøgelse, no. 31, pp. 497, 562, pl. vi, fig. 19.

1910. *Trophon clathratus*, Øyen, Krist. Vid. Selsk. Forh., no. 5, p. 27.

1910–15. *Trophon clathratus*, Odhner, Archiv Zool., K. Svensk. Vet.-Akad., vol. vii, no. 4, pp. 13, 24, 1910; var. *grandis*, K. Svensk. Vet.-Akad. Handl., vol. liv, p. 176.

1914. *Trophon clathratus*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 127, pl. xii, fig. 25.

1915. *Trophon clathratus*, A. Bell, Geol. Mag. [6], vol. ii, p. 168.

1915. *Trophon clathratus*, Johnson, Bost. Soc. Nat. Hist., Occ. Papers, vol. vii; Fauna of New England, pt. xiii, p. 131.

Distribution.—Fossil: Wexford, Boulder-clay of Belfast (additional). Pleistocene: Reykjavik (Pjeturss).

Remarks.—The type form of this ventricose and northern shell, generally known as *Trophon clathratus*, is clearly distinct from those described above as *T. truncatus* or its varieties. I have specimens of the former in my collection from the Waltonian Crag of Oakley, from Bridlington, Uddevalla, the Pleistocene of Christiania and elsewhere; they are practically the same, showing no indication of any close relationship to the latter species. Wood adopted Gould's name of *scalariformis* for the Crag form, including under it a variety (α) which corresponds with Prof. Sars' figure of *T. clathratus:* and another (β), a more slender shell, with finer sculpture and a longer canal; for this I now propose the varietal name *attenuata* (figs. 7 and 8). The latter variety agrees with the *Fusus lamellosus* of Gray[1] in its fine sculpture and long canal, but the body-whorl of Gray's shell is ventricose and the spire is very short, besides which his name had been used by Borson in 1821 for a different species. The dwarf form (fig. 6) I call var. *minor*.

Mr. C. W. Johnson identifies the *Fusus scalariformis* of Gould with the present shell (*op. cit.*), while M. Dautzenberg employs that specific name for a variety of *T clathratus*.[2] The latter authority adopts, however, *T. clathratus* and *T. truncatus* for the two species now in question, in which I follow him.

As pointed out by Wood ('Mon. Crag Moll.,' pt. i, p. 48) the *Fusus scalariformis* of Nyst is a different species.[1]

The Crag *Murex peruvianus* of Sowerby ('Min. Conch.,' vol. v, p. 47, pl. ccccxxxiv, fig. 1) may perhaps be the same; Lamarck's *Fusus Peruvianus* is different.

Var. **attenuata,** nov. Plate XXXVI, figs. 7, 8.

1848. *Trophon scalariforme*, var. *β*, S. V. Wood, Mon. Crag Moll., pt. i, p. 48, pl. vi, fig. 7*c*.

Varietal Characters.—More slender and somewhat smaller than the typical

[1] Zool. Beechey's Voyage, p. 118, pl. xxxvi, fig. 13, 1839.

[2] Camp. Scient. Pr. Monaco, vol. xxxvii (Mollusques), p. 150, 1912.

T. clathratus, with a less tumid body-whorl, finer and more numerous longitudinal costæ and a longer canal.

Dimensions.—L. 22 mm. B. 8 mm.

Distribution.—*Fossil:* Waltonian Crag: Little Oakley. Newbournian. Butleyan. Wexford.

Remarks.—This variety is fairly common at Oakley, occurring also at other localities of the Red Crag.

When a number of specimens from one Crag locality are examined it is not always easy to separate them from the type form of *T. clathratus*. The present shell is evidently a variety of that species.

Var. **exilis**, nov. Plate XXXVI, figs. 9, 10.

Varietal Characters.—More slender and smaller than the last variety, multicostate, with a narrow, fairly long canal, turning to the left.

Dimensions.—L. 15 mm. B. 6 mm.

Distribution.—*Fossil:* Wexford, Isle of Man.

Remarks.—This form, of which I have obtained several specimens from Wexford and one from the Manx drift, seems to be sufficiently distinct to deserve a special name. It may be grouped, I think, with *T. clathratus*, as var. *exilis*.

Trophon (Boreotrophon) Gunneri (Lovén). Plate XII, fig. 26; Plate XXXVIII, figs. 19, 20.

1838. *Fusus Peruvianus*, J. Smith (of Jordan Hill), Mem. Wernerian Nat. Hist. Soc., vol. viii, p. 52, pl. i, figs. 5, 6.
1872. *Trophon clathratus*, var., Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 492.
1880. *Trophon clathratus*, var. *Gunneri*, Stewart, Proc. Belfast Nat. Field Club, Appendix, p. 175.
1910. *Trophon clathratus*, var. *Gunneri*, Odhner, Archiv Zool., K. Svensk. Vet.-Akad., vol. vii, no. 4, pp. 13, 24.
1914. *Trophon Gunneri*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 128, pl. xii, fig. 26.
1915. *Trophon Gunneri*, A. Bell, Geol. Mag. [6], vol. ii, p. 168.

Distribution.—In addition to the localities for this shell given previously (p. 128) may be added the boulder-clay of Belfast, the high level drifts of Wales, Cheshire, Staffordshire and Lancashire and Uddevalla. I have also received several specimens from Wexford. It is distinctly a northern and arctic form. The first notice of it seems to have been that of Smith, given above.

[1] Coq. foss. Belg., p. 504, pl. xl, fig. 5, 1843.

Var. **Coddii,** nov. Plate XXXVIII, fig. 21.

Varietal Characters.—Belonging to the *T. Gunneri* group, but more slender and less ventricose than the one I take to be the type form of that species. The longitudinal costæ, moreover, are less numerous.

Dimensions.—L. 18 mm. B. 8 mm.

Distribution.—Fossil: Wexford.

Remarks.—I dedicate this little shell to my good friend, the Rev. Father Codd, in friendly acknowledgment of his valuable assistance in the collection of fossils from these promising Wexford beds.

It approaches in form and to some extent in sculpture a Norwegian species described by Prof. G. O. Sars as *T. clavatus*, but is not sufficiently near to justify its reference to the latter. It may be more probably regarded as a variety of *T. Gunneri.* Our present specimen is possibly not fully grown.

Trophon (Boreotrophon) mediglacialis (S. V. Wood). Plate XXXVIII, fig. 22.

1872. *Trophon mediglacialis*, S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. i, p. 28, pl. vii, fig. 12.

Specific Characters.—Shell elongato-fusiform, with rounded whorls; longitudinally ornamented by 8—10 obtuse and prominent costæ, and spirally by a few raised linear ridges; mouth ovate, canal elongate (S.V.W.).

Dimensions.—L. 10 mm. B. 4 mm.

Distribution.—Not known living.

Fossil: Middle glacial sands: Billockby, Hopton (? Gorleston) cliff.

Remarks.—In the Wood collection at the Norwich Museum there are half a dozen specimens labelled, in the well-known writing of the younger Wood, *Trophon mediglacialis*. They are the same in form and sculpture, but unfortunately are all imperfect, wanting the apex and the canal, which in the original description, quoted above, is said to have been elongate. The original figure given by the artist does not accurately represent the Norwich shells, the spiral sculpture being finer in the latter than in the drawing. It seems desirable therefore to refigure one of them, the identity of which is clearly established. The Billockby section has long been closed, but it may still be possible to obtain some fresh specimens of this interesting form from Hopton (Gorleston) cliff.

Sub-genus **TROPHONOPSIS,** Dautzenberg and Dollfus, 1882.

Trophon (Trophonopsis) muricatus (Montagu). Plate XII, fig. 18; Plate XXXVI, fig. 12.

1914. *Trophon muricatus,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i. p. 131, pl. xii, fig. 18.
1916. *Trophonopsis muricatus,* R. B. Newton, Journ. of Conch., vol. xv, p. 76.

Distribution.—Recent: Mediterranean, Adriatic and Ægean seas (additional).[1]
Fossil: Lenham (R. B. N.) (additional).

Remarks.—The name *Trophonopsis* as sub-generic has been proposed by MM. Dautzenberg and Dollfus for a group of small, slender, fusiform Trophons with clathrated sculpture, having the outer lip crenulated internally, the present species being taken as the type. I have obtained several fairly characteristic specimens of it in the Wexford gravels. *T. muricatus* seems to be a very variable form, both as recent and fossil.

As already stated, most of the Wexford Trophons belong to the northern group of these molluscs (*Boreotrophon*). If the present shell and those I regard as varieties of it are correctly identified, we have also another group of them from the same horizon whose affinities are distinctly southern.

Var. **Bellii,** nov. Plate XXXVI, fig. 15.

Specific Characters.—Belongs to the group with angulated whorls, but has much finer and more delicate sculpture.

Dimensions.—L. 14 mm. B. 7 mm.

Distribution.—Not recorded living.
Fossil: Wexford.

Remarks.—I dedicate this charming and, I think, distinct little shell to my old colleague Alfred Bell, who was among the first to call attention to the importance of the Wexford fauna.

Var. **similis,** F. W. Harmer. Plate XII, fig. 20; Plate XXXVI, figs. 13, 14; Plate XLIV, fig. 20.

1914. *Trophon muricatus,* var. *similis,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 133, pl. xii, fig. 20.

Distribution.—Fossil: Wexford gravels (additional).

Remarks.—Among the small Trophons alluded to above are about twenty which correspond more or less closely with a shell from Oakley which I described

[1] Omitted by accident from list in pt. i, p. 132.

on p. 133 as a variety (*similis*) of *T. muricatus.* They are characterised by the distinct angulation of the upper part of the whorls which causes a square and narrow shelf below the suture. My Wexford specimens vary in size, but have a somewhat similar and rather coarse clathrated sculpture.

In my Oakley specimens of this variety the outer lip is always strongly denticulated within; in most of those from Wexford, on the contrary, such ornament is not always apparent or is indistinct. M. Dautzenberg informs me that in recent shells a similar feature may sometimes be observed, especially when they are not fully grown. The absence of such ornament from some of these Wexford fossils may be partly due to abrasion, although the exterior of the specimens does not usually seem to be much worn.

Var. **cancellata,** nov. Plate XXXVI, fig. 16.

Varietal Characters.—Larger than any of the shells of the present group here described, with an elongate spire and coarse, strong cancellate sculpture; whorls convex, rounded, not angulate below the suture; mouth oval; outer lip regularly curved, not angulated.

Dimensions.—L. 16 mm. B. 8 mm.

Distribution.—Not recorded living.

Fossil: Wexford.

Remarks.—I group this shell, of which I have several of the same kind from Wexford, with those described above as a variety of *T. muricatus*, though with some doubt. Unfortunately in none of my specimens is the mouth, including the canal, perfect, nor does the outer lip show whether or not it was internally toothed. The sculpture is somewhat similar, however, to that of one of the examples of var. *similis;* it is an interesting form which deserves notice. Probably some future discoveries may throw further light on the subject.

Trophon (Trophonopsis) Bailyi (A. Bell, MS.). Plate XII, fig. 29; Plate XXXVI, fig. 11.

1914. *Trophon Fabricii,* var. *Bailyi,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 131, pl. xii, fig. 29.

Specific Characters.—Shell small, scalariform; whorls 5, but slightly convex, squarely angular above, with a distinct shelf below the suture, the last much the largest, two-thirds the total length, excavated below; ornamented by thin, sharply-edged longitudinal costæ which extend to the base and cross the shelf obliquely, with an occasional varix, spinous or pointed where it intersects the keel or near the outer lip, also by inconspicuous spiral ridges in the interspaces; spire

turreted, rapidly diminishing in size towards a blunt apex; mouth ovate; canal short, inclining to the left.

Dimensions.—L. 14 mm. B. 7 mm.

Distribution.—Not known living.

Fossil: Wexford gravels—Blackwater. Rathaspick, Co. Wicklow.

Remarks.—This form, discovered by Capt. James many years ago in the Irish drifts, has been hitherto known only from his unique specimen preserved in the Museum of the Geological Survey at Jermyn Street, where it still bears Prof. Forbes' original name of *Fusus* (*Trophon*) *Fabricii.* Mr. A. Bell has always contended that it should be regarded as specifically distinct, proposing to call it *T. Bailyi*, after the former palæontologist of the Irish Survey, a view which I now adopt.

It departs materially from the typical *T. Fabricii,* here given as *Ocinebra craticulata*, belonging to a group of small Trophons; of these, several different forms have been obtained at Wexford which I cannot satisfactorily identify. In some of them the whorls are squarely angulated above, in others they are rounded.

I have found one or two examples of the present shell in Father Codd's recent consignments, one of which I now figure. They correspond with the Jermyn Street specimen.

The variety and abundance of these small Trophons in the Wexford beds is remarkable. As stated above, I have some hundreds of them altogether in my collection. Taken as a whole they seem to form a special group, different from that either of any recognised horizon of our Pliocene or Pleistocene deposits, or of the existing seas of Great Britain or Scandinavia.

Some of these I have described provisionally as specifically distinct; others as varieties of recognised species to which, however, they do not always bear a very striking resemblance.

Trophon (Trophonopsis) Harmeri (A. Bell). Plate XXV, fig. 13; Plate XL, figs. 27, 28.

1915. *Trophon Harmeri,* A. Bell, Geol. Mag. [6], vol. ii, p. 167.

1915. *Trophon truncatus,* var. *Harmeri,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. ii, p. 201, pl. xxv, fig. 13.

Specific Characters.—Shell small, ovate, fusiform; whorls 5, convex, rounded, not angulate above, the last much the largest, nearly three-fourths the total length; ornamented by strong, closely-set costæ, and by a few distant but clearly-marked spiral lines; suture rather deep; mouth oval; outer lip regularly curved; canal short, bending to the left.

Dimensions.—L. 12—14 mm. B. 6—7 mm.

Distribution.—Fossil: Wexford gravels (additional).

Remarks.—The shell described on p. 201 from a Manxland specimen as a variety of *T. truncatus* may be regarded, I now think, as specifically distinct, under the name suggested for it by Mr. A. Bell of *Trophon Harmeri.* We have noticed a few specimens of it in our Wexford collections.

The affinities of this shell are not so much with *T. truncatus* as with the *T. decoratus* of Locard, a shell described in the 'Exped. scient. du Travailleur et du Talisman,' vol. i, p. 340, pl. xvii, fig. 5. 1897, of which the sculpture is similarly clathrated.

Trophon (Trophonopsis) barvicensis (Johnston). Plate XL, figs. 29, 30.

1818. *Murex barvicensis,* Johnston, Edin. Phil. Journ., vol. xiii, p. 221.
1853. *Trophon Barvicensis,* Forbes and Hanley, Brit. Moll., vol. iii, p. 442, pl. cxi, figs. 5, 6.
1867–71. *Trophon barvicensis,* Jeffreys, Brit. Conch., vol. iv, p. 318, 1867; vol. v, p. 218, pl. lxxxiv, fig. 5, 1869; in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 492, 1871.
1871. *Trophon barvicensis,* A. Bell, Ann. Mag. Nat. Hist. [4], vol. vii, p. 355.
1872. *Trophon barvicensis,* S. V. Wood, Mon. Crag Moll., 1st Suppl., p. 27, pl. vi, fig. 20.
1872. *Trophon barvicensis,* A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 210, 214.
1878. *Trophon Barvicensis,* G. O. Sars, Moll. Reg. Arct. Norv., pp. 248, 362, pl. xxiii, fig. 13.
1887. *Trophon Barvicensis,* Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, p. 28, pl. vi, figs. 16, 17.
1890. *Trophon barvicensis,* Carus, Prod. Faun. Medit., vol. ii, p. 383.
1901. *Trophon barvicensis,* Friele og Grieg, Norske Nordhav. Exped. (Mollusca), pt. iii, p. 97.
1901. *Trophon muricatus,* var. *barvicensis* (Conch. Soc. list), Journ. Conch., vol. x, p. 22.
1901. *Trophon barvicensis,* Brøgger, Norges Geol. Undersøgelse, no. 31, p. 658, pl. xviii, fig. 4.
1912. *Trophon (Trophonopsis) barvicensis,* Dautzenberg et Fischer, Camp. Scient. Pr. Monaco, vol. xxxvii (Mollusques), p. 157.

Specific Characters.—Shell small, slender, thin, fusiform, turreted; whorls 6—7, squarely angulate above, the last much the widest, with the canal two-thirds the total length, excavated below; ornamented by prominent lamellar and more or less spinous ribs, extending to the suture but hardly to the canal, clathrated by fine spiral ridges; spire elongate, regularly diminishing in size towards the apex; suture deep; mouth pyriform, angulate above and where it joins the canal; outer lip sometimes upturned with a sharp point or spine below the suture; canal rather long, narrow, nearly straight.

Dimensions.—L. 8—12 mm. B. 4—5 mm.

Distribution.—Recent: British coasts from Yorkshire and the Dogger bank to the Shetlands, west of Scotland, north and east of Ireland. Norway from the Christiania fiord to Finmark. Lofoten Islands. West Atlantic as far south as Morocco.

Fossil: Waltonian Crag: Walton-on-Naze, Little Oakley. Newbournian: Waldringfield, Shottisham. Wexford—Rosslare, Blackwater.

Pleistocene: Macclesfield, Gloppa, Moel Tryfaen, Garvel Park, near Greenock.

Remarks.—This species has been reported, always as a rare shell, from but few localities in the Crag. I have, however, one or two specimens from Oakley. Being fragile, fragments of it may have been easily overlooked. I have noticed a few examples in the Wexford stuff that has reached me. It has been found in places in our Pleistocene deposits.

Trophon (Trophonopsis) Kitchini, sp. nov. Plate XII, fig. 27.

1915. *Trophon Fabricii,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 130, pl. xii, fig. 27.

Specific Characters.—Shell small, solid, fusiform, turreted; whorls 6, convex, the upper part slightly angulate, the last two-thirds the total length, excavated below; ornamented by strong, rounded, prominent and distant longitudinal costæ, 6 on the body-whorl, reaching the base of the shell, and by well-marked spiral ridges which cross the costæ but do not extend to the suture; suture deep; mouth oval, angulate above; outer lip thickened externally by the labial rib; canal short, open, turning to the left.

Dimensions.—L. 17 mm. B. 9 mm.

Distribution.—Not known living.

Fossil: Isle of Man.

Remarks.—A specimen figured in Pl. XII, fig. 27, was referred both by the authorities at Jermyn Street and by myself to *Trophon Fabricii;* I am now disposed to consider it a different species, and, so far as I know, new. I have much pleasure in dedicating it to Dr. F. L. Kitchin, the palæontologist to the Geological Survey. It comes from the Jermyn Street collection and was obtained from the Manxland drift.

Genus **METZGERIA**, Norman, 1878.

Metzgeria alba (Jeffreys). Plate XIII, figs. 15, 16.

1897. *Meyeria pusilla,* Locard, Exped. scient. du Travailleur et du Talisman, vol. i, p. 336.
1914. *Meyeria alba,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 135, pl. xiii, figs. 15, 16.

Distribution.—Recent: (additional) Norwegian coast—Bergen, Hardanger, and as far south as the Azores.

Remarks.—In adopting the generic term *Meyeria* for this species on p. 135 I unfortunately lost sight of the fact, in common with one or two other authors, that, as pointed out by Canon Norman, it had been previously used by McCoy (1849) for a group of Crustaceans; our fossil should therefore be known by his

name of *Metzgeria alba.* Mr. Friele found this species sparingly as a recent shell along the Norwegian coast from Lindesnaes to Øxfiord, at depths from 97 to 191 fathoms, reporting it also from the Faroe Channel. It was dredged during the Talisman expedition off the Azores. A friendly reviewer suggests, moreover, that as the generic name *Triton*, de Montfort (1810) used by me on p. 120, had been previously adopted by Linnæus for a Cirriped—*Lampusia*, Schumacher, should take its place.[1]

Genus **SEARLESIA,** F. W. Harmer (*continued from p.* 147).

Searlesia Ravni, F. W. Harmer. Plate XIV, figs. 15—17; Plate XLIV, fig. 21.

1877–9. *Fusus Waelii*, S. V. Wood, Quart. Journ. Geol. Soc., vol. xxxiii, p. 120, 1877; Mon. Crag Moll., 2nd Suppl., p. 9, pl. i, figs. 10*a*—10*c*, 1879.

1890. *Fusus Waelii*, C. Reid, Plioc. Dep. Brit., p. 245.

1914. *Searlesia Ravni*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 142, pl. xiv, figs. 15—17.

Remarks.—In his 2nd Suppl. (*op. cit.*) Wood figured several specimens from Boyton, presumably of Coralline Crag age, identifying them, though with some hesitation, with *Fusus Waelii*, Nyst, a characteristic form of the Upper and Middle Oligocene of Belgium, Denmark and northern Germany, and I have obtained some others at Oakley corresponding with Wood's shell. Neither the Boyton nor the Oakley fossils present any obvious appearance of being derivative, and it seems improbable that such a distinctive Oligocene species should have continued to exist in the North Sea region as late as the Coralline, still less as the Red Crag period. I am inclined therefore rather to refer these Crag shells to that formerly described by me as *Searlesia Ravni.*

In the Wood collection at the Norwich Castle Museum there are some specimens from the Middle Oligocene of Belgium labelled *Fusus Waelii*, one of which I now figure, together with another of the Oakley shells for comparison. They have a superficial resemblance, but I do not think they are the same.

Judging from the figures of the Oligocene *Fusus Waelii* given by Beyrich,[2] von Koenen,[3] and more recently by Drs. Ravn[4] and Harder,[5] that species seems to have been a rather variable one, some of its varieties being more distinctly fusiform than my Belgian specimen, with a longer and nearly straight canal and sculpture different from that of the Crag shells. For these reasons I suggest that the

[1] Geol. Mag. [6], vol. iii, p. 473.

[2] Zeitschr. Deutsch. Geol. Gesellsch., vol. viii, p. 57, pl. v, figs. 2, 3, 1856.

[3] Palaeontographica, vol. xvi, p. 76, pl. vi, fig. 2, 1867.

[4] Mém. Acad. Roy. Sci. Danemark [7], vol. iii, p. 326, pl. vi, figs. 4, 5, 1907.

[5] Danm. geol. Undersögelse [2], No. 22, p. 81, pl. vi, figs. 24—27, 1913.

specimens referred to *F. Waelii* by Wood are Pliocene and not Oligocene, grouping them with the form described on p. 142 as *Searlesia Ravni.*

In his recent revision of the north Pacific Buccinidæ (Proc. Biol. Soc. Washington, vol. xxix, p. 7, 1916), Dr. W. H. Dall has adopted the generic term *Searlesia* for the group represented by *Trophon costifer*, S. V. Wood, of the English Crag, and by *Buccinum dirum*, Reeve, a species now living in Puget Sound.

Genus **FUSUS,** Klein (*continued from p.* 175).

Fusus Rigaccii, Cerulli-Irelli. Plate XXXVIII, fig. 16.

1911. *Fusus Rigaccii*, Cerulli-Irelli, Palaeont. Ital., vol. xvii, p. 239, pl. xxii, fig. 5.
1915. *Fusus Rigaccii*, A. Bell, Geol. Mag. [6], vol. ii, p. 167.

Specific Characters.—Shell fairly large, solid and strong, fusiform; whorls 7 or 8, decidedly convex, the last much the largest; ornamented by about twelve prominent costæ not so wide as the intervening spaces, extending from suture to suture, and by well-marked spiral ridges, parallel and equidistant, reaching the base of the shell, with finer ones between them, together with numerous lines of growth; suture distinct, not marginate; mouth ovate; canal narrow, long, turning slightly to the left; columella expanded in the centre.

Dimensions.—L. 60 mm. B. 20 mm.

Distribution.—Not known living.

Fossil: Isle of Man.

Upper Pliocene: Monte Mario, Farnesina.

Remarks.—Among a consignment of fossils from the Isle of Man recently received from the Rev. S. N. Harrison, Mr. Bell has discovered an imperfect specimen which so far as it goes appears to correspond with Sign. Cerulli-Irelli's figure and description of this species. It is an interesting find, as it supports the view that the fauna of the Manxland deposits contains a considerable number of typical Pliocene shells.

Fusus imperspicuus, S. V. Wood. Plate XXXVIII, figs. 17, 18.

1848–72. *Trophon imperspicuum*, S. V. Wood, Mon. Crag Moll., pt. i, p. 50, pl. vi, fig. 12, 1848; *Fusus imperspicuus*, 1st Suppl., pt. i, p. 29, pl. ii, fig. 4, 1872.
1871. *Trophon imperspicuum*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 146.
1872. *Fusus imperspicuus*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 203.
1890. *Fusus imperspicuus*, C. Reid, Plioc. Dep. Brit., p. 245.

Specific Characters.—Shell elongato-fusiform, turreted, of moderate size, rather thin, slender; whorls 8, convex, the last nearly two-thirds the total length;

ornamented by numerous closely-set flexuous costæ which die out towards or upon the body-whorl, and by fine unequal spiral costæ with slight granulation at the points of contact; suture fairly deep; spire elevated, regularly diminishing towards an acute point; mouth small, oval, angulate above and below; canal long, narrow, straight; outer lip thin, obliquely ridged externally.

Dimensions.—L. 22—25 mm. B. 8 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Sudbourn, Gomer. Waltonian: Little Oakley.

Remarks.—I figure two beautifully perfect specimens of this charming and delicate shell, belonging respectively to the geological museums of Cambridge and York. In the former the longitudinal costæ die out before they reach the body-whorl; in the latter they extend to the top of the mouth. The artist in the Monograph of the Crag Mollusca has hardly done justice to the beauty of this shell. Our fossils bear a superficial resemblance to the figure of Nyst's *F. Deshayesii*,[1] as pointed out by Wood, but differ materially from the shell figured by Dr. Ravn[2] under that name, and still more so from a typical specimen from the Middle Oligocene of Denmark which he has been kind enough to send me.

Genus **EUTHRIA,** Gray, 1850.

Euthria cornea (Linné). Plate XXXVII, figs. 7, 8.

1758. *Murex corneus*, Linné, Syst. Nat., ed. x, p. 754, no. 491.
1856. *Fusus corneus*, Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 280, pl. xxxi, fig. 3.
1872. *Euthria cornea* and vars., Bellardi, Moll. Terr. Terz. Piem., pt. i, p. 190, pl. xiii, figs. 2, 3.
1873–5. *Euthria cornea*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 300, no. 163, 1873; vol. v, p. 276, no. 58, 1874; vol. vi, p. 280, no. 297, 1875.
1877. *Euthria cornea*, de Stefani e Pantinelli, Bull. Soc. Malac. Ital., vol. iv, p. 94.
1882. *Euthria cornea*, Bucquoy, Dollfus et Dautzenberg, Moll. mar. Rouss., vol. i, p. 38, pl. vi, fig. 6.
1885. *Euthria cornea*, S. V. Wood, Quart. Journ. Geol. Soc., vol. xli, p. 68.
1886. *Euthria cornea*, Dollfus et Dautzenberg, Feuilles des jeunes Nat., Paris, vol. xvi, p. 103.
1886. *Fusus corneus*, Kendall and R. G. Bell, Quart. Journ. Geol. Soc., vol. xlii, p. 210.
1887. *Euthria cornea*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, p. 118, pl. xv, figs. 5, 9.
1890. *Euthria cornea*, Carus, Prod. Faun. Medit., vol. ii, p. 401.
1890–1904. *Euthria cornea*, vars., Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 233, no. 3125, 1890; Moll. Terr. Terz. Piem., pt. xxx, p. 34, 1904.
1890. *Fusus corneus*, C. Reid, Plioc. Dep. Brit., p. 245.
1897. *Euthria cornea*, A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 139, pl. i, fig. 2.
1901. *Euthria cornea*, Cossmann, Ess. Paléoconch. compar., vol. iv, p. 118, pl. vi, fig. 24.
1901–7. *Euthria cornea*, Scalia, Atti Accad. Gioen. Sci. Nat. Catania [4], vol. xiv, p. 14, no. 187, 1901; vol. xx, p. 36, no. 337, 1907.

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[1] Coq. foss. Terr. tert. Belg., p. 502, pl. xl, fig. 3, 1843.

[2] Mém. Acad. Roy. Sci. Danemark [7], vol. iii, p. 324, pl. v, fig. 15, 1907.

1911. *Euthria cornea*, Cerulli-Irelli, Palaeont. Ital., vol. xvii, p. 241, pl. xxii, figs. 11—15.
1913. *Euthria cornea*, Gignoux, Ann. Univ. Lyon, n. s. [1], vol. xxxvi, p. 496.
1917. *Euthria cornea*, Monterosato, Moll. viv. e quat. Tripoli, p. 22; Boll. Soc. Zool. Ital. [3], vol. iv.

Specific Characters.—Shell fusiform, strong and solid; whorls slightly convex; ornamented by flattened, inconspicuous spiral ridges which are more strongly marked towards the base of the shell, by fine and numerous lines of growth, and on the topmost whorls by strong, rounded, granular nodules and sometimes by a few fine longitudinal costæ; spire conical, more or less elongate; suture well marked; mouth oval, with an angular notch above; canal short, narrow, recurved; outer lip with a sharp edge, grooved within.

Dimensions.—L. 40 mm. B. 18 mm.

Distribution.—*Recent:* Mediterranean, widely and generally diffused, Adriatic, Ægean, Morea, Syria.

Fossil: St. Erth.

Miocene: Touraine, Italy.

Lower Pliocene: Siena, Biot.

Upper Pliocene: Colli Astesi, Bologna, Orciano, Val d'Era, Altavilla.

Pleistocene: Sicily—Messina, Monte Pellegrino, Ficarazzi, Catania, Rocca. Calabria—Reggio, Castroreale, Monteleone, Taranto, Gravina. Tripoli. Tuscany—Livorno, Valle Biaia.

Remarks.—This characteristic Mediterranean species, widespread both as recent and fossil, is reported from the English Pliocene of St. Erth only, where, however, it is not very common.

Mr. Bell points out (*op. cit.*, p. 139) that the shallow sub-sutural groove, characteristic of the recent shell, is absent in the St. Erth fossils. Profs. de Stefani and Pantinelli remark (*op. cit.*) that it is less prominent than usual in specimens from the Pliocene deposits of Siena.

Euthria gracilis, Locard. Plate XXXVII, fig. 6.

1836. *Fusus corneus* (*Murex*) var. *e*, *minor*, Scacchi, Cat. Conch. Reg. Neap., p. 12.
1882–98. *Euthria cornea*, var. *minor*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 39, 1882; *E. gracilis*, vol. ii, p. 778, 1898.
1892. *Euthria gracilis*, Locard, Coq. mar. Côtes de France, p. 104.
1915. *Euthria sp. nov.*, A. Bell, Geol. Mag. [6], vol. ii, p. 167.

Specific Characters.—Shell smaller and shorter than the typical *E. cornea*, ornamented by well-marked nodulous longitudinal costæ extending to and dying out on the last whorl, which is tumid and rounded.

Dimensions.—L. 25 mm. B. 14 mm.

Distribution.—*Recent:* Mediterranean.

Fossil: Cranstal, Isle of Man.

Remarks.—The shell figured under this name was obtained by the Rev. S. N. Harrison at Cranstal Point. My attention was drawn to it by Mr. A. Bell, who at first regarded it as an undescribed species of *Euthria*, but now refers it to the *E. gracilis* of Locard.[1] The authors of the 'Moll. mar. de Rousillon' identified *E. gracilis* in their first volume with *E. cornea*, var. *minor*, Scacchi, but afterwards adopted Locard's view that it is specifically distinct. It appears to differ from the type form of that species in the well-marked nodulous costæ of the upper whorls, unfortunately missing from the Manxland specimen, and in its body-whorl which is more tumid.

It seems now to be generally considered that the *E. minor* of Bellardi[2] is a different species.

Genus **TROSCHELIA**, Mörch, 1876.

Troschelia berniciensis (King). Plate XXXVII, figs. 15, 16.

1846. *Fusus Berniciensis*, King, Ann. Mag. Nat. Hist. [1], vol. xviii, p. 246.

1853. *Fusus Berniciensis*, Forbes and Hanley, Brit. Moll., vol. iii, p. 421, pl. cv, figs. 1, 2; pl. cvi, fig. 1.

1862–9. *Fusus Berniciensis*, Jeffreys, Brit. Conch., vol. iv, p. 341, 1867; vol. v, p. 219, pl. lxxxvii, fig. 1, 1869.

1872. *Trophon Berniciensis*?, S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. i, p. 21, pl. i, fig. 8.

1876. *Troschelia Berniciensis*, Mörch, Journ. de Conch., vol. xxiv, p. 370.

1878. *Boreofusus Berniciensis*, G. O. Sars, Moll. Reg. arct. Norv., pp. 278, 362, pl. xiv, fig. 12.

1882–1901. *Troschelia Berniciensis*, Friele, Norske Nordh. Exped. (Mollusca), pt. i, p. 25, 1882; pt. iii, p. 108, 1901.

1887. *Troschelia Berniciensis* (*Murex*), Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, p. 59, pl. ix, figs. 1, 2.

1892–7. *Neptunia Berniciensis*, Locard, Coq. mar. Côtes de France, p. 110, 1892; Exped. Scient. du Travailleur et du Talisman, vol. i, p. 353, pl. xvii, fig. 20, 1897.

1906–12. *Troschelia berniciensis*, Dautzenberg et Fischer, Camp. Scient. Pr. Monaco, vol. xxxii, p. 20, pl. ii, fig. 1, 1906; vol. xxxvii, p. 59, pl. i, fig. 3, 1912.

1911. *Troschelia Berniciensis*, Sykes, Proc. Malac. Soc., vol. ix, p. 341.

Specific Characters.—Shell large, spindle-form, fairly solid; whorls 7 or 8, convex, tumid in the centre, the last about two-thirds the total length; ornamented by numerous spiral ridges, alternately large and small, extending to the base of the shell, and by minute and closely-set curved longitudinal striæ which cross the ridges and produce slight decussation; spire regularly diminishing upwards, ending in a blunt, symmetrical point; suture deep; mouth oval; outer lip expanded, semicircular, incurved above, making a right angle with the body

[1] I have not been able to identify it myself, but give it on Mr. Bell's authority.

[2] Moll. Terr. Terz. Piem., pt. i, p. 199, pl. xiii, fig. 24, 1872.

whorl; inner lip forming a glaze on the columella; canal wide, of medium length, obliquely notched at the end; columella curved, slightly expanded where it joins the canal.

Dimensions.—L. 65–80 mm. B. 30—40 mm.

Distribution.—Recent: British coasts, principally north-eastern, Shetland, the Hebrides, Norwegian coast as far north as Finmark, and the Lofoten Islands, Faroes, Siberian coast, Spitzbergen, Davis Strait. Dredged to the north of Spain, the west of Portugal, the west of Morocco, off the French coasts of Africa (D. and F.), near the Azores, the Canaries and the Cape Verde Islands.

Fossil: Waltonian Crag: Little Oakley. Butleyan: Butley Mill. Icenian: near Norwich.

Remarks.—This rare and beautiful British shell, for the most part a deep water form, was reported by Wood with some doubt from the Icenian or Norwich Crag. Unfortunately, of the two specimens figured by him under that name, neither can now be traced. I have found several fragmentary specimens at Oakley, however, which, taken together, justify the inclusion of the name of this species in the fauna of that prolific locality. One of these I have figured, together with a recent example, for the guidance of collectors. Mr. A. Bell informs me that his brother obtained a variety of this species from the Red Crag of Butley Mill.

Genus **ATRACTODON,** Charlesworth, 1837.

Atractodon elegans, Charlesworth. Plate XXXVII, fig. 9.

1837. *Atractodon elegans*, Charlesworth, Mag. Nat. Hist., (n.s.) vol. i, p. 219, fig. 23.

1842–74. *Fusus (?) elegans*, S V. Wood, Ann. Mag. Nat. Hist. [1], p. 541, 1842; *Trophon elegans*, Mon. Crag Moll., pt. i, p. 46, pl. v, fig. 2, 1848; 1st Suppl., pt. i, pp. 22, 98, 1872; *T. (Atractodon) elegans*, pt. ii, pp. 177, 204, add. pl., fig. 13, 1874.

1871. *Fusus antiquus*, var., Jeffreys in Prestwich, Quart Journ. Geol. Soc., vol. xxvii, p. 492.

1872. *Fusus elegans*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 209.

1881. *Fusus (Atractodon) elegans*, Nyst, Conch. Terr. Tert. Belg., p. 16, pl. i, figs. 11*a*, *b*, *c*.

1892. *Fusus elegans*, Van den Broeck, Bull. Soc. Belg. Géol., vol. vi (Mémoires), pp. 121, 131.

1896. *Fusus elegans*, Bernays, Bull. Soc. Belg. Géol., vol. x (Mémoires), p. 131.

1901–4. *Chrysodomus elegans*, Cossmann, Ess. Paléoconch. compar., vol. iv. p. 100, 1901; *C. (Siphonorbis) elegans*, vol. vi, p. 121, pl. ix, figs. 3, 4.

Specific Characters.—Shell large, ovato-fusiform, spindle-shaped; whorls 6 or 7, convex, regularly decreasing in size upwards, the last much the largest; the top of the spire is obtuse or depressed, except that the apex, which is minute, is pointed and projecting, differing from that of any other form of this group; suture well marked; mouth ovate, angulate above; outer lip thin, gently curved; inner lip forming a callus upon the columella which in the adult shell is thickened, forming a large tooth or excrescence on the body-whorl immediately below its junction

with the outer lip; columella tortuous, excavated in the middle; canal short, twisted, turning to the left.

Dimensions.—L. 85—110 mm. B. 45—55 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Sutton, Orford. Waltonian: Little Oakley. Newbournian: Waldringfield, Newbourn, Felixstow.

Scaldisien, Poederlien: Antwerp.

Remarks.—The present species, originally described by Charlesworth from a specimen found on the beach at Felixstow, was considered by Wood as a Coralline Crag form derivative in the Red Crag, but it may be remarked that it occurs both in the Scaldisien and Poederlien of Antwerp in perfectly fresh condition, showing no signs of derivation. It does not appear to have been obtained either from the Diestien or the zone *à Isocardia cor* (Casterlien) of Belgium; but our knowledge of the molluscan fauna of those horizons is small and doubtless incomplete.

The figure given by Charlesworth (*op. cit.*) is good and characteristic, but his type specimen has for the present disappeared. It belonged, as he states, to Mr. W. S. Fitch of Ipswich, not, as has been sometimes supposed, to Mr. Robert Fitch of Norwich. Mr. Bell informs me that the former died in 1859, and that his collections were then sold by auction. The best existing example of the Red Crag *Atractodon* is in the Ipswich Museum. It was found by the late Mr. Canham in the section at Waldringfield, and was quite unworn.

Considerable difference of opinion has existed as to the correct nomenclature of this form. For the most part it has been referred to *Fusus*,[1] but it is hardly characteristic of that genus. More recently it has been grouped by M. Cossmann under the generic and sub-generic terms *Chrysodomus* and *Siphonorbis*.[2] On the whole, however, it is so different from anything belonging to those genera known to us that I prefer to retain the name of *Atractodon* originally given to it by Charlesworth.

Var. **inflata**, nov. Plate XXXVII, figs. 10—13.

Varietal Characters.—Differs from the type in its more convex and tumid whorls, in the shape of the mouth, and in its expanded and rounded outer lip.

Dimensions.—(Of Belgian specimen.) L. 54 mm. B. 29 mm.

Distribution.—*Fossil:* Waltonian Crag: Little Oakley (?).

Scaldisien, Poederlien: Antwerp.

Remarks.—The Belgian fossil given under this name is one of two which my friend M. Van de Wouwer was kind enough to allow me to select from his collection

[1] Jeffreys gives our shell in Prestwich's paper as *F. antiquus*, var.

[2] *Op. cit.*, vol. iv, p. 100; vol. vi, p. 121.

of Scaldisien mollusca during my last visit to Antwerp. It differs so materially from the type form of *Atractodon elegans*, which occurs, as stated above, in places in the Red Crag of Suffolk and is fairly common in the Belgian Crag, that I was inclined to regard it as specifically distinct; the peculiar form of the sharply pointed apex, however, and its characteristic sculpture correspond so exactly with those of *A. elegans* that it is difficult to separate them. The special difference is that in the present shell the whorls are more convex, and the outer lip is more expanded, making a less acute angle with the body-whorl and giving the mouth a different shape. The present variety is not distinctly spindle-shaped, nor does it show the callosity on the upper part of the inner lip characteristic of the normal form. Possibly it may not have attained its full growth. It is an interesting specimen and deserves notice. I have one or two fragments from Oakley which may be the same. As it occurs in the horizon of the Belgian Crag corresponding with the Waltonian, other examples may be found hereafter in our British deposits.

Since the above was written I have received a specimen from the York Museum (Pl. XXXVII, fig. 11) which is more or less intermediate between the typical form and the Belgian variety.

I have figured a specimen of the normal form of this shell (fig. 9) from Antwerp, not only to show the difference between it and the variety *inflata*, but also the non-derivative character (as I think) of the Scaldisien-Waltonian fossils.

Genus **NEPTUNEA**, Bolten (*continued from p.* 173).

Neptunea contraria (Linné). Plate XVI, figs. 1, 2; Pl. XXXVII, figs. 3—5.

1848. *Trophon antiquum*, var. *contraria carinata*, S. V. Wood, Mon. Crag Moll., pt. i, p. 45, pl. v, fig. 1*k*.
1868. *Fusus contrarius*, Fischer, Journ. de Conch., vol. xvi, p. 36.
1911. *Neptunea contraria*, Sykes, Proc. Malac. Soc., vol. ix, p. 336.
1914. *Neptunea contraria*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 156, pl. xvi, figs. 1, 2.

Distribution.—Recent: Porcupine Expedition, Sicilian Coast, Station 58.
Fossil; Coralline Crag: Boyton (additional).

Remarks.—During a recent visit to the York Museum Mr. Bell noticed a minute and very young specimen of *N. contraria* (possibly var. *informis*), about 5 mm. in length, showing but three only of the upper whorls. It bears a label in the writing of the late Dr. Reed, stating it was obtained from the Coralline Crag of Boyton. The Red Crag occurs also at that place, as has been long known, but from the appearance of our little shell I believe it is a genuine Coralline fossil. If this is so, it is interesting, forming another connecting link between the Coralline and Waltonian horizons, supporting also the view taken by Mr. Bell that the fauna

of the Coralline Crag found at Boyton is newer than that of Sutton and the Orford district (Gedgravian).

I give also a small Bridlington specimen from the Cambridge Museum of what appears to be the typical var. *carinata* of the Crag *N. contraria* (see my Pl. XVI, fig. 4). It corresponds with one in my collection (Pl. XXXVII, fig. 5) from the Scaldisien of Antwerp which I have figured with it.

Var. **informis,** F. W. Harmer. Plate XVI, fig. 6; Pl. XXXVI, figs. 30, 31.

1846. *Fusus contrarius*, E. Forbes, Mem. Geol. Surv., vol. i, p. 425.
1888–90. *Fusus contrarius,* A. Bell, Rep. Brit. Assoc. (Bath), p. 135, 1888; (Leeds), p. 414, 1890.
1915. *Neptunea contraria,* A. Bell, Geol. Mag. [6], vol. ii, p. 167.
1914. *Neptunea contraria,* var. *informis,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 160, pl. xvi, fig. 6.

Varietal Characters.—Shell thick and solid; whorls 6 or 7, convex, the last ventricose and expanded, much the largest; about three-fourths the total length excavated below; ornamented by spiral striæ, causing numerous flattened, well-marked, but not prominent ridges which reach the base of the shell[1]; spire much shorter than the typical Crag form or its recognised varieties, rapidly diminishing in size towards a blunt apex; suture oblique, deep; mouth short, more or less expanded; canal very short.

Dimensions.—L. 70 mm. B. 42 mm.

Distribution. — *Fossil:* Waltonian Crag: Little Oakley (rare). Icenian: Bramerton. Wexford (abundant), Isle of Man.

Remarks.—When studying the Neptuneas of the Oakley Crag, where the sinistral *N. contraria* occurs in great profusion, I noticed one or two which I regarded as an abnormal variety of that species, although a somewhat similar but recent shell now occurs at Spitzbergen and elsewhere in the arctic regions, the latter, which is specially characterized by its short spire and ventricose and expanded body-whorl, having been described and figured by Reeve, and afterwards by Leche and by Dautzenberg and Fischer as specifically distinct under the name of *Fusus deformis.* The present form has been also found in the Icenian Crag at Bramerton, as it may be hereafter at other localities and in the Red Crag. It is very common at Wexford, where dextral Neptuneas are very rare.

Prof. Forbes, who considered it a reversed variety of the British and dextral *N. antiqua,* as Jeffreys and other authorities have done since, felt the great abundance of this left-handed shell at Wexford to be puzzling. Writing in 1846 he remarked: " It is difficult to conjecture a sufficient cause for the prevalence of

[1] In sculpture, though not in form, the Wexford shells resemble to some extent those of the Sicilian Pleistocene Neptuneas (*cf.* Pl. XVI, fig. 4).

this monstrous over the normal form in two geological epochs." When the sinistral shells made their first recorded appearance in British seas, however—that is, in Waltonian times—they were normal, and not "monstrous."

The Wexford shells seem to be more nearly related to the arctic *N. deformis* than to the Crag *N. contraria.* The latter is comparatively a southern form, unknown from the north, while the former is an arctic species, now living in the seas of Spitzbergen, Nova Zembla, and the Behring Strait, but unrecorded from any more southern locality.[1] The question suggests itself, therefore, whether this abundant Wexford shell may not have been of northern origin, and be specifically distinct from the Crag *N. contraria.*

Neptunea antiqua (Linné). Plate XIX, fig. 1 ; Plate XXXVI, fig. 26.

1868. *Fusus antiquus,* Fischer, Journ. de Conch., vol. xvi, p. 35.
1888–90. *Fusus antiquus,* A. Bell, Rep. Brit. Assoc. (Bath), pp. 135, 139, 1888 ; (Leeds), pp. 411, 419, 1890.
1892. *Neptunia antiqua,* Locard, Coq. mar. Côtes de France, p. 110, fig. 98.
1894. *Fusus antiquus,* Kendall, Journ. Isle of Man Nat. Hist. Soc., vol. i, p. 419.
1901. *Chrysodomus antiquus,* Cossmann, Ess. Paléoconch. compar., vol. iv, p. 99, fig. 28.
1903. *Trophon antiquus,* Lamplugh, Mem. Geol. Surv. (Isle of Man), p. 475.
1913. *Chrysodomus antiquus,* Gignoux, Ann. Univ. Lyon, (n. s.) [1], vol. xxxvi, p. 494.
1914. *Neptunea antiqua,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 168, pl. xix, fig. 1.

Remarks.—Among the Wexford fossils there are one or two dextral Neptuneas which, although smaller than the normal *N. antiqua* of our British seas, may be referred to that species, resembling it in form and as far as their worn condition allows in the fine spiral sculpture of the recent shell. With them there are a few left-handed shells of a similar type, differing from the variety *informis* in sculpture, in their more slender character, their non-ventricose body-whorl, their narrower and non-expanded mouth and their longer canal. The surface of this shell, moreover, is generally polished and of a darker colour.

With one of these I figure also a recent specimen of what is supposed to be the reversed form of the recent *N. antiqua* from the Moray Firth (fig. 28). It is a rare and local shell, and was called by Jeffreys *Fusus antiquus,* var. *contrarius.* If, however, the sinistral Crag *N. contraria* is a distinct species, and it has been so considered by most authorities from the time of Linné onwards, that varietal term is inapplicable. I suggest that *inversa* might be used instead.

As to whether the Wexford shell (fig. 27) should be regarded as a reversed

[1] *N. deformis* is now generally known under the generic term *Pyrolofusus,* proposed by Mörch for sinistral forms of *Neptunea.* To apply that name to the present shell, however, might involve the adoption of it for the Crag *N. contraria,* causing, I think, much and unnecessary confusion. M. Cossmann, moreover, objects to the use of *Pyrolofusus* (*op. cit.*, vol. iv, p. 99).

form of the Wexford *N. antiqua* or a survivor of the Crag *N. contraria*, I express no opinion. It does not appear to be the variety *informis* described in the last paragraph but closely resembles the dextral specimen figured with it.

Neptunea despecta (Linné), var. **tornata** (Gould). Plate XXXVI, fig. 29.

1841–70. *Fusus tornatus*, Gould, Inv. Mass., ed. 1, p. 286, fig. 201, 1841 ; ed. 2, p. 374, fig. 641, 1870.
1872. *Chrysodomus tornatus*, Dawson, Canad. Nat. (n. s.), vol. vi, p. 399.
1878. *Fusus tornatus*, Leche, Kongl. Svensk. Vet.-Akad. Handl., vol. xvi, pt. 2, pp. 67, 83, pl. ii, fig. 28.
1912. *Neptunea antiqua tornata*, Dautzenberg et Fischer, Camp. scient. Pr. Monaco, vol. xxxvi (Mollusques), p. 78, pl. ii, figs. 5—7.

Varietal Characters.—Shell short, fusiform, turreted; whorls convex, flattened above with a sloping shelf below the suture, the last much the largest, three-fourths the total length, excavated below; ornamented by spiral ridges, two of them prominently shown on the upper whorls, more numerous on the last, the lower ones being less clearly marked ; spire conical, regularly diminishing in size upwards ; suture fairly deep ; mouth oval, equalling the spire, angulated above ; outer lip curved, slightly angulated by one of the spiral ridges ; canal short, bending to the left.

Dimensions.—L. (of Wexford specimen) 45 mm. B. 24 mm.

Distribution.—*Recent :* Arctic Norway, Kara Sea, Spitzbergen, Nova Zembla, Iceland, Newfoundland, Labrador, Greenland.

Fossil : Wexford.

Pleistocene : Sweden, Siberia, Montreal, Quebec, Rivière-du-Loup, Labrador.

Remarks.—The specimen from Wexford figured under this name belongs to the carinated and northern *despecta* group. It agrees closely, both in form and sculpture, with that figured by Prof. Leche as *Fusus tornatus*, and to a somewhat less extent with Gould's typical American shell (*op. cit.*), though it is rather more slender than the latter. The range of this group, both as recent and fossil, is distinctly arctic and northern, extending westward also to the northern part of the American continent.

It may be pointed out that the sinistral Neptuneas found at Wexford outnumber the dextral ones by about ten to one.

Neptunea tenuistriata, sp. nov. Plate XXXVII, figs. 1, 2.

1847. *Fusus striatus*, Reeve, Conch. Icon., vol. v (Fusus), pl. xi, fig. 42 (*F. ventricosus* in index).
1872. *Trophon ventricosus ?*, S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. i, p. 22, pl. iii, fig. 4.

Specific Characters.—Shell rather thin, ovato-fusiform; whorls 6, convex, the last much the largest, four-fifths the total length, rounded but not so tumid as in

N. ventricosa, excavated below; spire conical, regularly diminishing in size towards a blunt point; suture fairly deep; ornamented by excessively fine and inconspicuous spiral lines extending to the base of the shell, and by the lines of growth; mouth oval, angulate above, rather longer than the spire; outer lip thin, gently curved; inner lip forming a very thin glaze on the columella which is excavated in the middle; canal short, rather wide, turning to the left.

Dimensions.—L. 40 mm. B. 21 mm.

Distribution.—*Recent:* Banks of Newfoundland.

Fossil: Bridlington.

Remarks.—On p. 171, Pl. XXIII, fig. 20, I described a specimen from the Newbournian Crag of Felixstow as *Neptunea ventricosa* which corresponded very closely with the recent Newfoundland shell given by Gould as *Fusus ventricosus*, but not so nearly with that represented by Wood, although with some doubt, under the same name. There is a Bridlington fossil, however, at the Sedgwick Museum agreeing with Wood's figure. It bears a note in Jeffreys' writing—"*Fusus* (*Trophon*) *ventricosus*, Wood, not De Kay," De Kay's species being the one described by Gould (*op. cit.*, p. 373). The body-whorl of the latter is larger in proportion to the total length (four-fifths), is decidedly ventricose, the spire is shorter and obtusely conical, and the canal turns more distinctly to the left. The specimen from Bridlington now given as *Neptunea tenuistriata*[1] is undoubtedly the recent Newfoundland *Fusus striatus* of Reeve, a more slender and as I think a distinct form with a longer spire, of which I received some examples from my friend Dr. Sparre Schneider some years ago. One of these is now figured together with the Bridlington fossil. I agree with Jeffreys that they are not the *F. ventricosus* of Gould, but whether the difference is specific or varietal may be perhaps a matter of opinion. I suggest to the student a comparison of Gould's figure together with mine of 1914 (Pl. XXIII, fig. 20) on the one hand, with that of Reeve's *F. striatus*, Wood's *Trophon ventricosus* of 1872 (*op. cit.*, p. 22), and those now figured, on the other.

Genus **SIPHO**, Klein, 1753 (*continued from* p. 200).

Klein's generic name *Sipho* is still used on the continent of Europe in most conchological works. It has been recently claimed, however, that *Tritonofusus* (Beck, 1847) should be substituted for it[2] on the ground that at a meeting of the

[1] As the specific name *striatus* had been used for a shell belonging to this group before the time of Reeve, I suggest for the present form that of *tenuistriata*.

[2] The generic term *Tritonofusus* was at one time adopted in America in place of *Sipho*, but it has already been changed to *Colus*, as by Dr. Dall (Proc. Biol. Soc. Washington, vol. xxix, p. 7, 1916), and by Mr. C. W. Johnson (Bost. Soc. Nat. Hist., Occ. papers, vol. vii; Fauna of New England, pt. xiii, p. 137, 1915).

International Zoological Congress some years ago a resolution was passed that no names older than the 10th edition of Linné should be recognised. Originally exceptions were to be permitted under special circumstances, but at a subsequent Congress, after a long discussion and in spite of the strenuous opposition of the President and Secretary of the Commission appointed to consider the matter, a hard and fast rule was carried, by a majority of votes only, that the Law of Priority should be strictly enforced in every case. This rule may be important generally, though at any time it may be revoked, but I submit that exceptions to it, as in the case of an old and firmly established name like the present one, may be equally so. To this day *Sipho* and not *Tritonofusus* is used by French Conchologists like Dollfus, Dautzenberg, Fischer, and Cossmann who apparently decline to be bound by the votes of a body, the majority of the members of which have no knowledge of the special circumstances of the case. *Sipho* is generally used, moreover, in recent Scandinavian works. It seems to me that the study of fossil names is less important than that of fossil shells. In the present case the proposed alteration in the old nomenclature, which has no special scientific value, would tend to cause confusion to students of the Crag deposits, rather than remove it.

Sipho torrus (Locard). Plate XXXVIII, figs. 10, 11.

1897–9. *Neptunea torra,* Locard, Expéd. scient. du Travailleur et du Talisman, Mollusques testacés, vol. i, p. 361, pl. xvii, figs. 21—25, 1897; Coq. mar. Côtes de France, p. 63, 1899.

1902. *Neptunea torra,* Pallary, Journ. de Conch., vol. l, p. 9.

1906. *Sipho torrus,* Dautzenberg et H. Fischer, Camp. scient. Pr. Monaco, vol. xxxii (Mollusques), p. 22, pl. ii, figs. 2—5.

1908. *Neptunea* (*Sipho*) *torra,* Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iv, p. 147, pl. cxxiii, fig. 3; pl. cxxv, figs. 2, 3.

Specific Characters.—Shell solid, slender, turreted, lanceolato-fusiform, smooth and polished; whorls 7 or 8, slightly convex, the last two-thirds the total length, excavated below; ornamented by exceedingly fine inconspicuous spiral striæ and by the lines of growth; spire acuminate, regularly decreasing in size towards a small, obtuse and planorboid apex; suture slight; mouth ovate, narrow, angulate above; canal rather short, turning to the left.

Dimensions.—L. 30—40 mm. B. 12—15 mm.

Distribution.—*Recent:* west Atlantic coast from the Bay of Biscay to Morocco.
Fossil: Wexford gravels.

Remarks.—In a parcel of Wexford fossils received from Father Codd, I noticed the one now figured under the above name, which, although imperfect, corresponds in M. Dautzenberg's opinion with some specimens of the recent species, *Sipho torrus,* obtained during the expedition of the Travailleur and Talisman, from a depth of 750 metres; one of these he has kindly allowed me to figure. The

species in question is said by M. Locard to be a variable one; although in some respects not unlike *S. tortuosus* and *S. gracilis*, it is considered by himself and by the other authorities quoted above to be specifically distinct. I know of nothing else in the Crag to which our shell can be satisfactorily referred. Like the *S. menapiæ* of A. Bell, figured above (p. 186, Pl. XXIII, figs. 17—19), it is unknown from the eastern basin of the British Pliocene.

Sipho gracilis (Da Costa). Plate XX, figs. 3, 4; Plate XXXVIII, figs. 1, 2.

1887. *Neptunea gracilis*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, p. 72, pl. iii, fig. 4.
1890. *Fusus gracilis*, A. Bell, Rep. Brit. Assoc. (Leeds), pp. 410, 414, 417.
1892. *Neptunea gracilis*, Locard, Coq. mar. Côtes de France, p. 111.
1894. *Fusus gracilis*, Kendall, Journ. Isle of Man Nat. Hist. Soc., vol. xii, p. 419.
1901. *Sipho gracilis*, Cossmann, Ess. Paléoconch. compar., vol. iv, p. 100, pl. iv, fig. 12.
1914. *Sipho gracilis*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 175, pl. xx, figs. 3, 4.

Remarks.—As stated on p. 176 of the present work, the Belgian fossil described by Nyst as *Fusus gracilis* approaches more nearly the one I have taken as the type of the Crag *S. curtus*, Jeffreys, and is probably the same.[1] The two forms are closely allied, though my continental friends follow Jeffreys and Wood in considering them specifically distinct. From a geological point of view the matter does not seem to me of great importance, so long as their stratigraphical position can be clearly defined. I have found both at Oakley, but *S. curtus* with its many varieties is the more abundant at that place. On the contrary, among the Siphos lately received from Wexford the specimens belonging to this group are generally of the recent *gracilis* type, one or two approaching the slender variety *Coulsoni*, of which an example was shown on my Pl. XX, fig. 6. Two of the Wexford forms of *S. gracilis* are represented by figs. 1 and 2 of Pl. XXXVIII.

Var. **convoluta** (Jeffreys). Plate XXV, figs. 6, 7; Plate XXXVIII, figs. 3, 4.

1914–5. *Sipho gracilis*, var. *convoluta*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 178, 1914; pt. ii, pl. xxv, figs. 6, 7, 1915.

Distribution.—(Additional) Waltonian Crag: Little Oakley. Wexford gravels.

Remarks.—The Wexford fossil figured under the present name seems to correspond with this variety of *S. gracilis*, which may be distinguished from the type by its elongated spire, its more convex whorls, and its comparatively slender form. With the other Siphos from the same locality, it is thicker and stronger than those found in British seas at the present day.

[1] This name has always seemed to me exceedingly inappropriate.

Sipho Jeffreysianus (Fischer). Plate XXIV, figs. 3, 4; Plate XXXVIII, fig. 12.

1892–7. *Neptunea Jeffreysiana,* Locard, Coq. mar. Côtes de France, p. 110, 1892; Expéd. scient. du Travailleur et du Talisman, vol. i, p. 360, 1897.
1914. *Sipho Jeffreysianus,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 196, pl. xxiv, figs. 3, 4.

Distribution.—Fossil: (additional) Isle of Man, Wexford.

Remarks.—I am sorry to find that in the legend to my Pl. XXIV, the numbers referring to the two figures of this species were accidentally reversed; the Oakley specimen should be fig. 3, and not 4; the recent one fig. 4, and not 3.

The present species is not very rare in the Wexford gravels.

Sipho menapiæ, var. **hibernica** (A. Bell). Plate XXIII, fig. 17.

1914. *Sipho menapiæ,* var., F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 186, pl. xxiii, fig. 17.
1915. *Sipho hibernicus,* A. Bell, Geol. Mag. [6], vol. ii, p. 167.

Varietal Characters.—Differs from the type in size, in its elongate spire and its somewhat more convex whorls.

Dimensions.—L. 50 mm. B. 22 mm.

Distribution.—Not known living.

Fossil: Wexford, Isle of Man.

Remarks.—In the first part of the present Memoir I figured some closely allied but somewhat different shells under Mr. Bell's name of *Sipho menapiæ*, one of which (Pl. XXIII, fig. 17) is larger and much longer in the spire than the others, the whorls being rather more convex. In a recent paper Mr. Bell has recorded this as specifically distinct, under the name of *S. hibernicus.* The Siphos of this group in my collection from Wexford vary considerably, however, some of them being of a more or less intermediate character, and I am, therefore, inclined still to group them with *S. menapiæ*, adopting Mr. Bell's name *hibernica* as varietal for the elongate form.

Sipho islandicus (Chemnitz). Plate XX, figs. 1, 2; Plate XXXVIII, figs. 5—8.

1887. *Neptunea islandica,* Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, p. 71, pl. xiii, fig. 2.
1890. *Fusus islandicus,* A. Bell, Rep. Brit. Assoc. (Leeds), pp. 410, 423.
1892. *Neptunea islandica,* Locard, Coq. mar. Côtes de France, p. 111, fig. 99.
1910–15. *Sipho islandicus,* Odhner, Archiv Zool., K. Svensk. Vet.-Akad., vol. vii, no. 4, p. 24, 1910; K. Svensk. Vet.-Akad. Handl., vol. liv, p. 203, 1915.
1914. *Sipho islandicus,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 187, pl. xx, figs. 1, 2.

Distribution.—Fossil: (additional) Wexford gravels, western Hebrides.

Remarks.—To the fossil localities for this species given on p. 187 may be added

the Wexford gravels, from which Mr. Bell reported it in 1890. We have lately received a number of specimens of it from that locality, most of them small or broken, as to the identification of which, however, taken as a whole, there can be little doubt. Those here figured correspond with a small recent and slender variety from Bergen (fig. 5) rather than with the large shell given on Pl. XX, fig. 1, as typical of this species.

There are some broken specimens in the British Museum from Lewis in the western Hebrides, labelled *S. propinquus.* One of them, however, shows a mammiform apex, and others the flattened spiral sculpture characteristic of *S. islandicus*, to which species, I think, they should be referred.

Sipho latericeus (Möller). Plate XX, figs. 10—12; Plate XXXVII, fig. 14.

1863. *Fusus latericeus*, Jeffreys, Rep. Brit. Assoc. (Newcastle-on-Tyne), Trans. Sect., p. 77.
1880. *Trophon latericeus*, Stewart, Proc. Belfast Nat. Field Club, Appendix, p. 175.
1887. *Neptunea latericea*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, pl. xiv, fig. 14.
1890. *Trophon latericeus*, A. Bell, Rep. Brit. Assoc. (Leeds), pp. 410, 414.
1910–15. *Siphonorbis latericeus*, Odhner, Archiv Zool., K. Svensk. Vet.-Akad., vol. vii, no. 4, p. 24, 1910; *Sipho latericeus*, K. Svensk. Vet.-Akad. Handl., vol. liv, p. 204, 1915.
1914. *Sipho latericeus*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 189, pl. xx, figs. 10–12.

Remarks.—The specimen here figured is one of two from the Jermyn Street Museum which were found at Moel Tryfaen. They show the distinguishing sculpture more clearly than those represented in Pl. XX, figs. 10—12. Mr. Stewart reports this species from the boulder-clay of Co. Antrim.

S. latericeus appears to be a variable species; the recent Norwegian form given by Prof. G. O. Sars[1] is larger than those of Pl. XX, and the spire is longer; it seems to be very similar to the *Neptunea* (*Sipho*) *pertenuis* of Mr. E. R. Sykes.[2] We have others from Wexford which are intermediate. Possibly they are all varieties of the same species.

Sipho pygmæus (Gould). Plate XXXVIII, figs. 13—15.

1841–70. *Fusus islandicus*, var. *pygmæus*, Gould, Rep. Inv. Mass., ed. 1, p. 284, fig. 199, 1841; *F. pygmæus*, ed. 2, p. 372, fig. 639, 1870.
1872. *Trophon Sabinii*, S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. i, p. 23, pl. ii, fig. 15.
1872. *Fusus pygmæus*, Jeffreys, Ann. Mag. Nat. Hist. [4], vol. x, p. 245.
1915. *Colus pygmæus*, Johnson, Bost. Soc. Nat. Hist., Occ. papers, vol. vii; Fauna of New England, pt. xiii, p. 130.

Specific Characters.—Shell rather thin, small and delicate, fusiform; whorls 7,

[1] Moll. Reg. arct. Norv., p. 276, pl. xv, fig. 8.
[2] Proc. Malac. Soc., vol. ix, p. 339, fig.

convex; spire elongate, gradually diminishing in size towards an acute apex; suture well marked; ornamented by fine spiral ridges and by the lines of growth; mouth ovate, angulate above; canal short, slightly twisted, turning sharply to the left; columella tortuous; outer lip thin.

Dimensions.—L. 15–25 mm. B. 6—10 mm.

Distribution.—*Recent:* New England coasts—Massachusetts, Halifax, Eastport, Grand Manan.

Fossil: Bridlington.

Remarks.—The fossils from Bridlington here given are from the Museums at Cambridge and York, where they are labelled *F. Sabinii* and *F. curtus* respectively; they agree rather, however, with the American species *S. pygmæus*, a specimen of which, by the kindness of Mr. C. W. Johnson, I am able to figure with them for comparison. Jeffreys says, in the paper quoted above, that *F. pygmæus* is not *F. Sabinii*, as considered by Wood, and that *F. curtus* is the American form of *F. islandicus.* On p. 183, I have adopted the specific name *Sabinii* for some Crag shells corresponding more nearly with the figures given by Hancock and Jeffreys (*op. cit.*), while I retain the unsuitable one *curtus* for the abundant Red Crag form which in his list of Crag shells in Prestwich's paper (p. 492) was clearly identified with the *Trophon gracile* of Wood's Monograph of 1848 (pl. vi, fig. 10). In any case it is difficult to understand why Jeffreys called it *curtus.* It is almost impossible to ascertain what his *F. curtus* really included. From Mr. Headley's Bridlington collection Mr. A. Bell has sent for my inspection two fragmentary and different specimens each bearing in Jeffreys' writing the name of *F. curtus.* They are not alike and they are not Wood's *T. gracile.* *F. curtus* was neither figured nor described by Jeffreys, although in his written allusions to it he claimed the name as his own; much confusion has arisen in consequence.[1]

Another instance of the same kind exists in the occurrence at Bridlington of a fossil described by Wood as *Trophon Leckenbyi* (*Sipho*), 1st Suppl., pt. i, p. 24, pl. vii, fig. 1, which has been dredged also in a fossil condition off the Shetlands; a form nearly allied to this is recorded by Mr. Friele as *Neptunea* (*Sipho*) *curta* (Norske Nordhav. Exped. (Mollusca), pt. i, pl. ii, fig. 2).

Sipho propinquus (Alder). Plate XX, figs. 8, 9; Plate XXXVIII, fig. 9.

1887. *Neptunea propinqua,* Kobelt, Icon. schalentrag. europ. Meeresconch., vol. i, p. 76, pl. xiv, fig. 6.
1890. *Fusus propinquus,* A. Bell, Rep. Brit. Assoc. (Leeds), p. 410.
1892. *Neptunea propinqua,* Locard, Coq. mar. Côtes de France, p. 111.

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[1] The *Fusus curtus* of Smith was in Wood's opinion a different shell (see Mon. Crag Moll., pt. ii, p. 314).

1899. *Sipho (Siphonorbis) propinquus*, Posselt, Medd. om Grønl., vol. xxiii, p. 178.
1903. *Trophon propinquus*, Lamplugh, Mem. Geol. Survey (Isle of Man), p. 475.
1914. *Sipho propinquus*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. i, p. 195, pl. xx, figs. 8, 9.

Distribution.—Recent: (additional) Greenland (Posselt).

Remarks.—The specimen here figured from Wexford agrees with the recent shell, except that like many others from that region it is very thick and solid. The type form had not been recorded from the Crag previously to 1913, but it may have been overlooked by collectors under the impression that it was an immature specimen of some larger species.

PLEUROTOMIDÆ (*continued from* p. 302).

For reasons similar to those stated on p. 370, and with many apologies to my friendly critic in the 'Geological Magazine,'[1] I continue the use of the terms *Pleurotoma* and Pleurotomidæ. It has been suggested recently that these should be changed to *Turris* and Turridæ on the ground that the publication of *Turris* by Bolten (1798) preceded that of *Pleurotoma* by Lamarck (1799) though by a few months only.

I submit that when a name has been in general use in all parts of the world, without protest, for more than 100 years, it should be allowed to stand. Such an interference with geological literature should be regarded, I consider, as a matter of expediency and not of principle,[2] each case being decided on its merits and in accordance with the views of those who have specially to deal with it. Unless their general consent can be obtained any attempt to force the revival of a name which has long been obsolete would probably result in failure.

In a letter just received, a distinguished continental Conchologist informs me that neither he nor his associates have any present intention of using *Turris* instead of *Pleurotoma*, a change which he considers would be unnecessary, inexpedient, and likely to interfere with the usefulness of our standard works of reference. Evidently he does not intend to be among the first to support it. At present there seems to be but little prospect of its general adoption; meanwhile I am disposed to "wait and see."

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[1] Geol. Mag. [6], vol. iii, p. 472, 1916.

[2] Prof. Huxley held a similar opinion. Discussing the retention or otherwise of a nearly obsolete name he said that sometimes "it may be well to allow justice to give way to expediency." (Quart. Journ. Geol. Soc., vol. xxvi, p. 33, 1870.)

Genus **PLEUROTOMA**, Lamarck (*continued from* p. 210).

Pleurotoma contigua (Brocchi). Plate XXXIX, figs. 1, 2.

1814. *Murex contiguus*, Brocchi, Conch. foss. subap., vol. ii, p. 433, pl. ix, fig. 14.
1872. *Pleurotoma contigua*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 213.
1877. *Pleurotoma contigua*, Bellardi, Moll. Terr. Terz. Piem., pt. ii, p. 38, pl. i, fig. 24.
1890–1904. *Pleurotoma contigua*, Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 265, no. 3928, 1890; Moll. Terr. Terz. Piem., pt. xxx, p. 42, 1904.
1896. *Pleurotoma* (*Hemipleurotoma*) *contigua*, Cossmann, Ess. Paléoconch. compar., vol. ii, p. 80.
1915. *Pleurotoma contigua*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. ii, p. 205.

Distribution.—Not known living.

Fossil : Miocene, Pliocene : Italy. Scaldisien : Belgium.

Remarks.—This form, occurring in the Miocene and Pliocene of Italy, is nearly related to *P. turricula*, the principal difference appearing to be that in it the central spiral ridge on each whorl is distinctly granulate, whereas in *P. turricula* such granulation, where present, is very fine and is confined to the upper part of the shell. Some authorities regard *P. contigua* as a variety of the latter, while Brocchi, its original describer, Prof. Sacco, with Prof. Issel, M. Cossmann and other authorities treat it as specifically distinct. On p. 205 of the present Memoir I expressed a doubt whether it should be included in our lists of Crag fossils ; most of our specimens are too much worn to show the distinguishing sculpture. I have obtained an unworn example, however, from the Scaldisien of Antwerp, which I have here figured and believe to be *P. contigua*. If it is correctly identified the latter may turn up any day in our Crag deposits ; in that case my Belgian fossil may be useful for comparison.

Genus **DRILLIA**, Gray (*continued from* p. 230).

Drillia Jeffreysii, sp. nov. Plate XXXIX, fig. 35.

1869. *Pleurotoma galerita*, Jeffreys, Brit. Conch., vol. v, p. 221, pl. cii, fig. 6.
1899. *Drillia semicolon*, Norman, Ann. Mag. Nat. Hist. [7], vol. iv, p. 134.

Specific Characters.—Shell minute, delicate, fusiform ; whorls 6, angulated in the centre, slightly concave above, the last excavated below ; ornamented by a single row of strong oblique tubercles on the keel with fine lines above it, a ridge next the suture and stronger ridges on the body-whorl below it ; spire short, conical ; mouth oval, angulate, with a small notch above ; outer lip angulated by the keel ; canal short, narrow,

Dimensions.—L. 6 mm. B. 2·5 mm.

Distribution.—Recent : western Hebrides.

Fossil : Coralline Crag : near Woodbridge.

Remarks.—The small specimen from the Coralline Crag here represented seems to agree closely with the one dredged by Carpenter and Thomson in 189 fathoms, about 50 miles N. of the Butt of the Lewis, which was figured by Jeffreys in his British Conchology and referred by him to *P. galerita*, a Sicilian species described by Philippi.[1] If Philippi's figure is correctly drawn, however, the latter differs so widely, both in form and sculpture, from the shells now in question that it is difficult to consider they can be the same. The one given below as *D. galerita* (Pl. XXXIX, fig. 36) seems to agree more nearly with what Philippi regarded to be the typical form of that species. I suggest the specific name of *Jeffreysii* for the Crag specimen (fig. 35) and for that described by Jeffreys.

Those figured in Pl. XXVII, figs. 16 and 17 as *Drillia icenorum*, with which Wood identified the *P. semicolon* of pl. vi, fig. 3 *a* of his Monograph of 1848, are larger and more coarsely sculptured, belonging, I consider, to a different species.

A granulated spiral ornamentation is a common feature of the fossil Pleurotomidæ, making the correct identification of many of our Crag specimens, often imperfect or waterworn, a matter of considerable difficulty. *D. Jeffreysii*, for example, resembles more or less nearly the North German Miocene *Pleurotoma Hosiusi* of Von Koenen, but a careful comparison of specimens of the two shows, I think, that they are distinct.

Whatever our shell may be, I do not consider it is the *P. galerita* of Philippi; Canon Norman quotes a letter on the subject he had received from the Marchese di Monterosato (*op. cit.*), in which the latter states that Jeffreys' shell is a different species from the Sicilian Fossil.

Drillia galerita (Philippi). Plate XXXIX, fig. 36.

1915. *Drillia galerita*, F. W. Harmer, Plioc. Moll. Gr. Brit., pt. ii, p. 228.

Remarks.—On p. 228 I mentioned the occurrence of several specimens from Oakley which I was then disposed to refer to *D. galerita*, Phil. One of these (fig. 35) I describe above as a new species under the name of *D. Jeffreysii*; another (fig. 36), which corresponds more nearly with his type form, may perhaps be a variety of Philippi's species.

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[1] Enum. Moll. Sic., vol. ii, p. 172, pl. xxvi, fig. 15.

Genus **CLATHURELLA,** Carpenter (*continued from* p. 241).

Clathurella linearis (Montagu). Plate XXVIII, figs. 26—29; Plate XXXIX, fig. 34.

1864. *Pleurotoma* sp., E. Forbes, Mem. Geol. Surv., vol. i, p. 426, no. 128.
1915. *Clathurella linearis*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. ii, p. 237, pl. xxviii, figs. 26 – 29.

Distribution.—Fossil : Wexford gravels (additional).

Remarks.—In the work quoted above Prof. Forbes speaks of having found, at the locality named, a small species of *Pleurotoma* allied to *P. linearis*, having 12 ribs on the body-whorl, as to which he says that "the whorls are convex, spirally furrowed, and strongly ribbed longitudinally." The specimen now figured, which I have recently found in our Wexford collection, though not identical with the typical British shell, agrees with that description and is probably the same as that of Prof. Forbes; if so, the name of *C. linearis* may be added to the list of the Wexford fossils.

Clathurella minuta, sp. nov. Plate XXXIX, fig. 33.

1848. *Pleurotoma castanea*, S. V. Wood, Mon. Crag Moll., pt. i, p. 57, pl. vii, fig. 3.
1871. *Defrancia linearis*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 143.

Specific Characters.— Shell minute, slender, elongato-ovate, whorls slightly convex; ornamented by obtuse, inconspicuous longitudinal costæ and by regular, distinct but very fine spiral striation which crosses the ribs; mouth ovate with a thickened outer lip and a labial sinus; canal very short.

Dimensions.—L. 4·5 mm. B. 1·75 mm.

Distribution.—Not known living.

Fossil : Coralline Crag: Sutton, Ramsholt.

Remarks.—This charming little shell was known to Wood from two specimens only which he had found at Sutton. The one now figured belongs to the Ipswich Museum and was obtained, Mr. Bell thinks, by the late Rev. H. Canham at Ramsholt. Jeffreys regarded it as a variety of the recent British form *C. linearis*, while Forbes and Hanley identified it with *Mangilia rufa.* I agree that it is not the *Fusus castaneus* of Brown,[1] which seems to have been a somewhat larger shell, and prefer to consider it a distinct species.

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[1] Brown, Illust. Recent Conch. Gt. Brit., ed. 2, p. 6, pl. v, figs. 43, 44, 1844.

Genus **MANGILIA**, Risso (*continued from* p. 251).

Mangilia Bertrandi (Payraudeau). Plate XXXIX, figs. 21—23.

1826. *Pleurotoma Bertrandi*, Payraudeau, Cat. Moll. Corse, p. 144, no. 288, pl. vii, figs. 12, 13.
1844. *Pleurotoma Bertrandi*, Philippi, Enum. Moll. Sic., vol. ii, p. 168 (not *P. Bertrandi*, vol. i, p. 198, pl. xi, fig. 20).
1878. *Mangelia Bertrandi*, de Stefani e Pantinelli, Bull. Soc. Malac. Ital., vol. iv, p. 128.
1884. *Mangelia Bertrandi*, Monterosato, Nomen. Gen. e Spec. Conch. Medit., p. 129.
1890. *Mangilia Bertrandi*, Carus, Prod. Faun. Medit., vol. ii, p. 417.
1892. *Mangilia Bertrandi*, Locard, Coq. mar. Côtes de France, p. 60, fig. 48.
1905. *Mangelia bertrandi*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iii, p. 333, pl. xciii, figs. 6, 7.
1910. *Mangilia Bertrandi* and var. *elongatula*, Cerulli-Irelli, Palaeont. Ital., vol. xvi, p. 53, pl. v, figs. 7—9.
1914. *Mangilia Bertrandi*, Cipolla, Palaeont. Ital., vol. xx, p. 142, pl. xiii, fig. 12.

Specific Characters.—Shell small, slender, subfusiform; whorls 6—8, slightly convex, the last excavated below, more than half the total length; ornamented by about 6 flexuous and thin longitudinal costæ which reach the suture and the base of the shell, having interspaces wider than the costæ; spiral striation exceedingly faint, if any; suture well-marked; spire elongate, ending in a sharp point; mouth narrow, oblong, angulate above, passing without break into a short canal; outer lip thickened outside by the labial rib with a distinct labial sinus.

Dimensions.—L. 10 mm. B. 3 mm.

Distribution.—Recent : Mediterranean, Adriatic, Morea, Ægean.

Fossil : Coralline Crag : Gedgrave. Waltonian : Little Oakley.

Lower Pliocene : Siena.

Upper Pliocene : Monte Mario, Livorno, Altavilla.

Remarks.—As stated on p. 266, there has been much difference of opinion among students of the Crag as to the correct identification of the present form. Through the kindness of Sign. Cerulli-Irelli, who has sent me some verified fossils from Monte Mario for comparison, I am able to figure what he considers a typical example of this species. The *M. Bertrandi* of Payraudeau, who originally described it, was a very small shell, about 10 or 12 mm. in length. It is found living in many parts of the Mediterranean but, so far as I can ascertain, has only been reported as fossil from two or three localities of the Italian Pliocene.

I have recently found a specimen in the Sedgwick Museum among some small Mangilias which seems to correspond with the Italian fossils. There are several others, unfortunately imperfect, in my Oakley Collection, which are possibly the same.

Mangilia assimilis, sp. nov. Plate XXXIX, fig. 20.

Cf. 1905. *Mangelia bertrandi,* Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iii, p. 333, pl. xciii, fig. 6.

Specific Characters.—Shell small, solid, turreted; whorls but slightly convex; ornamented by a few strong and distinct ribs which extend to the suture but are discontinuous, and to the base of the shell; spire slender, elongate; suture well marked; mouth narrow; outer lip thickened by the labial rib; labial notch distinct; canal very short.

Dimensions.—L. 10 mm. B. 3·5 mm.

Distribution.—Not recorded living.

Fossil: Waltonian Crag: Little Oakley.

Remarks.—I have made many attempts to identify the fossil here figured but without success. M. Dautzenberg, to whom I sent a photograph, suggested it might be *Mangilia Goodalliana,* Leach, and was kind enough to send me some specimens for comparison. When placed side by side with the Crag shell the latter seems to be too unlike to be referred to it, even as a variety. The nearest thing I can discover is one of the much enlarged figures of *M. Bertrandi* given by Kobelt (*op. cit.*, vol. iii, pl. xciii, fig. 6), but it is hardly the same; it differs too widely, moreover, from the typical *M. Bertrandi* sent to me by Sign. Cerulli-Irelli to be identified with that species. It seems a distinct form deserving notice. I have therefore called it provisionally *M. assimilis.*

Mangilia costato-striata (S. V. Wood MS., Kendall and R. Bell). Plate XXXIX, figs. 18, 19.

1886. *Pleurotoma costato-striata,* Kendall and R. Bell, Quart. Journ. Geol. Soc, vol. xlii, p. 210.
1898. *Pleurotoma costato-striata,* A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 137.

Specific Characters.—Shell very small, slender; whorls 6, slightly convex, the first without sculpture, the others ornamented by 8 to 9 thin and rather prominent longitudinal ribs, and by 8 inconspicuous spiral striæ; on the last whorl the ribs are oblique and flexuous, hardly reaching the base of the shell; spire elongate, ending in a blunt point; mouth oblique, rather narrow, passing without break into a short and open canal; outer lip thickened by the labial rib, not expanded, with a well-marked labial notch.

Dimensions.—L. 7—8 mm. B. 3 mm.

Distribution.—Not recorded living.

Fossil: St. Erth.

Remarks.—The fossils here represented are the type specimens referred to by

Mr. A. Bell in his St. Erth paper (*op. cit.*) as being in the Sedgwick Museum, Cambridge. I feel very grateful to my friend, the late Prof. Hughes, that I have been entrusted not only with them but with so many other valuable shells. Our fossil approaches some figures of the *M. angusta* of Jan, not published by the author but subsequently. It differs sufficiently, however, from those given by Bellardi and others not to be referred to that species, and I have little hesitation in supporting Wood's view that it should be considered distinct.

Mangilia Gwynii (Etheridge and Bell). Plate XXXIX, fig. 24.

1898. *Pleurotoma* (*Mangilia*) *Gwynii*, A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 136.

Specific Characters.—Shell minute, slender, fairly solid, spindle-shaped; whorls 6, convex; ornamented by strong, rounded, sinuous and oblique longitudinal costæ, and on the upper whorls by coarse inconspicuous spiral striæ; mouth comparatively long, narrow, angulated above; canal short and open; apex and nucleus smooth.

Dimensions—L. 6 mm. B. 2 mm.

Distribution—Not known living.

Fossil: St. Erth.

Remarks.—This little shell, which Mr. Bell believes to be the only perfect specimen of the kind that has been obtained, is now in the British Museum; it was described by him in 1898 on the authority of Dr. Gwyn Jeffreys as a new species.

Genus **RAPHITOMA,** Bellardi (*continued from p.* 276).

Raphitoma concinnata (S. V. Wood). Plate XXXIX, figs. 3, 4.

1848–72. *Clavatula concinnata*, S. V. Wood, Mon. Crag Moll., pt. i, p. 61, pl. vii, fig. 11 *a*, 1848; *Pleurotoma hispidula*, 1st Suppl., pt. i, p. 42, pl. iii, fig. 3, 1872.
1871. *Pleurotoma decussata*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, pp. 143, 487.
1872. *Pleurotoma concinnata*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 210.

Specific Characters.—Shell turreted, subfusiform; whorls 7, distinctly convex; slightly compressed above, especially on the last; ornamented by about 15 strong flexuous costæ which tend to die out towards the base of the shell, and by fine inconspicuous spiral ridges; suture rather deep; spire elongate, regularly diminishing in size; mouth ovate, angulate above; sutural sinus distinct but not deep; outer lip gently curved, with a sharp edge; inner lip forming a thin glaze on the pillar; columella with a swelling in the middle of the mouth and a slight umbilical chink near the base.

Dimensions.—L. 20 mm. B. 8 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Sutton, Gedgrave. Newbournian: Waldringfield.

Remarks.—The fossils from the Coralline Crag, one belonging to the Jermyn Street Collection, the other to the Sedgwick Museum, Cambridge, and here described as *Raphitoma concinnata*, seem to correspond with one of those figured by Wood in 1848 (*op. cit.*, fig. 11 *a*) under that specific name. There is another from Waldringfield in the Ipswich Museum, somewhat worn, which may be the same. Wood's fig. 11 *b* is possibly a different species.

In 1871 Jeffreys identified this shell with *Pleurotoma decussatum*, Philippi, but Wood did not accept this view, nor can I; our Crag shell does not appear to me to agree, even remotely, with Philippi's figure.

In 1872, in his first Supplement, Wood figured a Crag fossil as *P. hispidula* (*op. cit.*, p. 42) which I have referred on p. 259 to the Belgian *Raphitoma similis*, Nyst, giving on my Pl. XXIX, figs. 27—29, verified examples of both species. In the paragraph quoted, Wood suggested that *R. concinnata* might be regarded as a variety of *P. hispidula*. A review of all the facts, however, leads me to consider it distinct and to revert to my old friend's original name of *R. concinnata* for it, as the brothers Bell did in 1872 (*op. cit.*).

Raphitoma nevropleura (Brugnone). Plate XXXIX, fig. 6.

1862. *Pleurotoma nevropleurum,*[1] Brugnone, Mem. alc. Pleur. foss. Palermo, p. 35, pl. i, fig. 24.

1873. *Raphitoma proxima*, Cocconi, Moll. Mioc. e Plioc. Parma, p. 65, pl. i, figs. 17, 18.

1875. *Raphitoma nevropleura*, Seguenza, Boll. R. Com. Geol. Ital., vol. vi, p. 210, no. 230.

1877. *Raphitoma nevropleura*, Bellardi, Moll. Terr. Terz. Piem., pt. ii, p. 310, pl. ix, fig. 22.

1890. *Raphitoma nevropleura*, Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 283, no. 4342.

1906. *Pleurotoma* (*Raphitoma*) *nevropleura*, Dollfus, Comptes rendus Assoc. Franç. Avance. Sciences (Lyon), p. 311.

1914. *Daphnella* (*Raphitoma*) *nevropleura*, Cipolla, Palaeont. Ital., vol. xx, p. 181, no. 61, pl. iii, fig. 13.

Specific Characters.—Shell slender, fusiform; whorls 8 or 9, but little convex, somewhat depressed below the suture; ornamented by thick, rounded, sinuous costæ and by very fine transverse striations; spire elongato-conical; suture slight; mouth oblong, narrow, angulate above; labial sinus indistinct; outer lip gently curved, nearly continuous with the canal.

Dimensions.—L. 14 mm. B. 5 mm.

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[1] As stated on p. 256 of the present Memoir, and for the reason there given, I retain the feminine termination for the specific names of the present group of shells.

Distribution.—Not known living.

Fossil: Newbournian Crag: Foxhall.

Upper Pliocene: Colli Astesi, Parma, Altavilla.

Remarks.—The specimen here figured is from the Jermyn Street Collection, and is said to have been found at Foxhall. It corresponds with the Italian fossil *R. nevropleura* more nearly than with anything else I can discover, being specially characterised by its strong sculpture, the comparative flatness of the whorls, and the absence of any distinct break between the mouth and the canal. The figures given by Brugnone and Bellardi show the spire to be somewhat longer than in our Crag fossil, but their shells belong to the same group and may be, at least, varieties of the same species. *R. nevropleura* is a rather rare Italian and Sicilian form, reported only from the Astian or Upper Pliocene deposits of that region and from the Miocene of Touraine and Mayenne (Dollfus).

Raphitoma tenuistriata (A. Bell). Plate XXIX, figs. 31, 32; Plate XXXIX, fig. 16.

1915. *Raphitoma tenuistriata,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. ii, p. 263, pl. xxix, figs. 31, 32.

Distribution.—Fossil: Wexford gravels (additional).

Remarks.—Mr. Bell has sent me a perfect specimen of this interesting fossil from Wexford, which shows clearly the fine spiral striation characteristic of the present species. Hitherto it has been reported as fossil from the English Crag only, and is unknown as a living shell.

Raphitoma mitrula (S. V. Wood). Plate XXIX, figs. 23—25; Plate XXXIX, figs. 10—13.

1915. *Raphitoma mitrula,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. ii, p. 270, pl. xxix, figs. 23—25.

Remarks.—At stated on p. 270, this species is exceedingly common in the Waltonian Crag; I have obtained more than 1000 specimens from Oakley alone. They vary considerably in size, in the greater or less convexity of the whorls, the comparative length of the spire and the shape of the mouth; I have been tempted to consider some of them as specifically distinct. A careful examination of the whole collection, however, has led me to a final conclusion that they may be regarded as varieties of one species. For the assistance of collectors and in the hope of saving them trouble, I have figured two or three more of the Oakley fossils.

They may possibly represent some incipient species, forms which, had the

conditions of the Coralline-Waltonian period continued to be favourable, not only to the existence of the present group of shells but generally to molluscan life, might have resulted in their becoming specifically distinct. The opening of communication between the Crag basin and northern seas, shown by the sudden appearance of so many boreal shells toward the end of the Waltonian epoch, seems, however, to have brought about a different state of things resulting in the gradual disappearance not only of *R. mitrula* and its congeners but of most of the southern species of mollusca which up to that time had been abundant in Anglo-Belgian seas.

There is a box of 40 or 50 specimens, labelled *Pleurotoma mitrula* (G. 1898), in the Wood Collection at the British Museum (Natural History) at South Kensington, most of them agreeing with those figured by me on Pl. XXIX, which Wood seems to have regarded as the type form of the present species.

Raphitoma compacta (Etheridge and Bell). Plate XXXIX, fig. 7.

1898. *Pleurotoma compacta*, A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 138.

Specific Characters.—Shell short, minute, fusiform, fairly strong and solid; whorls 6, convex, subangulate, the last more than half the total length; ornamented by rather distant longitudinal costæ reaching nearly to the base of the shell, and crossed by fine and sharply-edged spiral ridges, causing slight tuberculation at the points of contact; suture deep; mouth oblique, narrow, oval, angulate above, passing into a well-defined and short canal; outer lip slightly angulated by one of the spiral ridges; inner lip forming a thin glaze on the columella.

Dimensions.—L. 5 mm. B. 2·5 mm.

Distribution.—Not known living.

Fossil: St. Erth.

Remarks.—This interesting little shell from St. Erth belongs to the Jermyn Street Museum, and is figured by the kind permission of the Director of the Geological Survey. Messrs. Etheridge and Bell, unable to identify it with anything before described, recorded it under the above not inappropriate name. Mr. Bell suggests it may be a young shell, but it is quite perfect and its distinguishing sculpture is clearly shown.

Raphitoma substriolata, sp. nov. Plate XXXIX, figs. 14, 15.

Specific Characters.—Shell small, strong and solid, smooth and polished, elongato-subfusiform; whorls convex; without spiral sculpture but ornamented by 8 or 9 strong, prominent, clearly-cut longitudinal costæ which reach the base

of the shell; suture fairly deep; mouth ovate, passing without break into a very short and open canal; labial notch distinct.

Dimensions.—L. 12 mm. B. 4 mm.

Distribution.—*Recent:* Arcachon.

Fossil: Waltonian Crag: Little Oakley.

Remarks.—On p. 270, Pl. XXIX, fig. 26, I described some Oakley fossils as *R. striatula;* they belonged to the *R. mitrula* group, but differed, specifically, as I thought, from that species. I suggested they might represent the one figured by Philippi as *P. striolata*, Scacchi, to which name, in my opinion for reasons then given, the latter had no right. I have received lately, however, from my friend M. Dautzenberg some specimens which he considers to agree more nearly with Philippi's *P. striolata*, and these I find to correspond very closely with some in my Oakley collection which I had been unable to identify; one of each I have now figured as *R. substriolata*, my objection to the name *striolata* for them being the same as in the case mentioned above.

The present shell differs from *R. mitrula* in its general appearance and texture; it is stronger, more solid, its surface being polished and without spiral sculpture and its costæ less numerous and more distinctly chiselled. I have about half a dozen of them from Oakley; they seem to separate themselves clearly from any variety known to me of the polymorphous species *R. mitrula*.

Raphitoma nuperrima (Tiberi). Plate XXXIX, fig. 5.

1844. *Pleurotoma decussatum*,[1] Philippi, Enum. Moll. Sic., vol. ii, p. 174, pl. xxvi, fig. 23.

1873–5. *Raphitoma decussata*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 296, no. 91, 1873; vol. v, p. 276, no. 34, 1874; vol. vi, p. 210, no. 231, 1875.

1878. *Raphitoma nuperrimum*, Tiberi, Test. Nov., p. 14, pl. ii, figs. 6, 7.

1883–98. *Raphitoma nuperrima*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. ii, p. 792, 1898.

1892. *Raphitoma nuperrima*, Locard, Coq. mar. Côtes de France, p. 59, fig. 47.

1905. *Raphitoma nuperrimum*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iii, p. 385, pl. xcviii, fig. 7.

1878. *Raphitoma nuperrima*, Monterosato, Enum. e Sinon. Conch. Medit. (Giorn. Sci. Nat. ed. Econ. Palermo, vol. xiii, p. 45).

Specific Characters.—Shell small, elongato-fusiform, slender, delicate; whorls 8, more or less convex, obtusely angulate above, the last excavated below, passing almost without break into a narrow canal; spire attenuate; suture well-marked; ornamented by about 12 flexuous longitudinal costæ, and by fine, well-marked

[1] The name *P. decussatum* had been previously used (in 1839) by Couthouy for a North American shell.

spiral lines; mouth long, narrow, almost equal in length to the spire; outer lip gently rounded, but little expanded.

Dimensions.—L. 12 mm. B. 4 mm.

Distribution.—Recent: Mediterranean, very rare (Locard).

Fossil: Coralline Crag.

Upper Pliocene: Livorno.

Pleistocene: Naso, Barcellona-Castroreale, Ficarazzi, Monte Pellegrino.

Remarks.—I have found a specimen from the Coralline Crag in the Sedgwick Museum at Cambridge which seems to correspond with that figured by Locard (*op. cit.*), and with some of those given by Prof. Kobelt. Either this species is a variable one or the latter author has represented two species under the same name. Our Crag shell agrees best with Kobelt's fig. 7 and with those described and figured by Locard (*op. cit.*) and by Philippi as *P. decussatum.* The sculpture seems to be of a distinct and special character.

Raphitoma Hörnesii (Mayer). Plate XXXIX, fig. 8.

1858. *Pleurotoma Hoernesii,* Mayer, Journ. de Conch., vol. vii, p. 387, pl. xi, fig. 1.
1898. *Pleurotoma Hœrnesii,* A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 138.

Specific Characters.—Shell minute, fusiform; whorls 7, convex, depressed above; ornamented by rather strong costæ, flexuous on the body-whorl and by fine well-marked spiral ridges; spire elongate; suture deep; mouth oval; canal very short.

Dimensions.—L. 7 mm. B. 2·75 mm.

Distribution.—Not known living.

Fossil: St. Erth.

Miocene: Saint Jean de Marsac, near Dax.

Remarks.—The shell figured under this name is from the Jermyn Street Museum and was obtained by Mr. E. T. Newton at St. Erth. Mr. A. Bell has identified it with a Miocene species from the neighbourhood of Dax in south-west France.

It is considerably smaller than the specimen figured by Mayer and does not correspond exactly with his figure, but it belongs to the same group.

Raphitoma consimilis, sp. nov. Plate XXXIX, fig. 9.

Specific Characters.—Belonging to the *R. Hörnesi* group, but having finer spiral sculpture and a longer spire; it resembles *R. Keepingi* also, but has a shorter and wider mouth and a shorter canal than in that species.

Dimensions.—L. 9 mm. B. 3 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Gedgrave.

Remarks.—This shell might perhaps be regarded as a variety of *R. Hörnesi.* It is one of several of the same kind, unnamed, at present in the Montagu-Smith Collection at the Sedgwick Museum, Cambridge.

Raphitoma Keepingi (Etheridge and Bell). Plate XXXIX, fig. 17.

1898. *Pleurotoma Keepingi*, A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p.138.

Specific Characters.—Shell small, fusiform, turriculate; spire long, about half the total length; whorls 7—8, convex, indistinctly carinate above; ornamented by 9 or 10 strong, broad and straight costæ, crossed by fine spiral ridges; suture deep; mouth long and narrow; canal short.

Dimensions.—L. 10 mm. B. 3 mm.

Distribution.—Not known living.

Fossil: St. Erth.

Remarks.—The specimen figured under this name is the one found by Mr. Keeping and named after him by Messrs. Etheridge and Bell. It is now in the Sedgwick Museum at Cambridge and has been identified by the latter as the one originally described by him. He considers that, though related to *R. Hörnesi*, it may be regarded as a distinct species.

Genus **HAEDROPLEURA** (*continued from* p. 255).

Haedropleura Cornishi (Etheridge and Bell).

1898. *Pleurotoma (Mangilia) Cornishi*, A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 137, pl. i, fig. 10.

Specific Characters.—Shell minute, ovato-fusiform; whorls 6—7, convex, turreted, obtusely angulate above; ornamented by a few rather distant but stout, rounded and prominent longitudinal ribs, crossed by fine well-marked spiral striæ; suture deep; spire short, with a blunt apex; mouth expanded above, narrowing below; canal very short, open.

Dimensions.—L. 6 mm. B. 4 mm.

Distribution.—Not known living.

Fossil: St. Erth.

Remarks.—Mr. A. Bell informed me that this very distinct species was

represented by a unique specimen in the Museum at Penzance, which is unfortunately not now accessible, owing to the war. I hope I may be able to figure it in some future volume of this memoir. I should be glad to do so in memory of the late Mr. J. Cornish, after whom Mr. Bell named this interesting fossil; it was owing to a chance conversation between Mr. Cornish and myself in 1883 that Wood's attention was first called to the importance of the St. Erth deposits. Mr. Bell has now ascertained there is another specimen in the British Museum (Natural History).

Genus **DONOVANIA,** Bucquoy, Dautzenberg and Dollfus, 1882.

Donovania candidissima (Philippi). Plate XXXIX, fig. 39.

1836–44. *Buccinum candidissimum*, Philippi, Enum. Moll. Sic., vol. i, p. 222, pl. xi, fig. 18, 1836; vol. ii, p. 189, 1844.
1868. *Nesæa candidissima*, Tiberi, Journ. de Conch., vol. xvi, p. 77, pl. v, fig. 4.
1873. *Lachesis candidissima*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 346, no. 172.
1890. *Donovania candidissima*, Carus, Prod. Faun. Medit., vol. ii, p. 416.
1892. *Donovania candidissima*, Locard, Coq. mar. Côtes de France, p. 71, fig. 57.
1898. *Lachesis (Nesæa) candidissima*, A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 139.

Specific Characters.—Shell small, white, delicately sculptured; ornamented by rather strong longitudinal costæ, intersected and granulated by transverse ridges; whorls 6 or 7, slightly convex; spire elongate; suture fairly deep; mouth oval, angulated above; outer lip expanded, thickened and denticulated within; canal short, open.

Dimensions.—L. 10 mm. B. 4 mm.

Distribution.—Recent: Mediterranean—Provence, Antibes, Catania, Adriatic.
Fossil: St. Erth.

Pleistocene: Monte Pellegrino.

Remarks.—The St. Erth shell now figured is from the Wood collection in the British Museum (Natural History). It seems to be a southern form, very rare both as recent and fossil.

Donovania multilineata (Etheridge and Bell). Plate XXXIX, fig. 38.

1898. *Lachesis multilineata*, A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 137, pl. i, fig. 9.

Specific Characters.—Shell minute, slender, widest at the base; whorls 6, slightly convex, the last more than half the total length; spire elongate, diminishing regularly in size towards a blunt apex; ornamented by numerous

excessively fine and closely-set spiral striæ, hardly visible except under the microscope, but without longitudinal sculpture; suture oblique, well-marked; mouth short, wide, oval, angulate above; outer lip inflected, thickened, much expanded; inner lip forming a thin, narrow glaze upon the columella; canal wide, very short, open.

Dimensions.—L. 5 mm. B. 2 mm.

Distribution.—Not known living.

Fossil: St. Erth.

Remarks.—This St. Erth fossil is another specimen from the British Museum, and was described in 1898 by A. Bell as then unknown except from the above most interesting deposit. Neither the latter nor I have been able to find anything in the works accessible to us or in the collections we have examined that approaches it.

Donovania lineolata (Tiberi). Plate XXXIX, fig. 37.

1868. *Nesæa lineolata*, Tiberi, Journ. de Conch., vol. xvi, p. 76, pl. v, fig. 5.
1898. *Donovania lineolata*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. ii, p. 793.
1890. *Donovania lineolata*, Carus, Prod. Faun. Medit., vol. ii, p. 417.
1892. *Donovania lineolata*, Locard, Coq. mar. Côtes de France, p. 71.
1892. *Nesæa lineolata*, A. Bell, Ann. Rep. Yorks. Phil. Soc., pp. 63, 76.
1911. *Donovania lineolata*, Sykes, Proc. Malac. Soc., vol. ix, p. 331.

Specific Characters.—Shell minute, fairly solid, elongato-turreted; whorls but slightly convex, the last about two-thirds the total length, regularly diminishing in size to a blunt point; ornamented by numerous longitudinal costæ, clathrated by strong spiral striæ and granulated when they intersect; suture distinct; mouth short, oval; outer lip expanded, thickened, grooved within; inner lip slight; canal very short.

Dimensions.—L. 6·5 mm. B. 3 mm.

Distribution.—*Recent:* coasts of Provence, Corsica, Sardinia, Naples, Palermo. Ionian Sea, Gallipoli. Porcupine Expedition—Adventure Bank.

Fossil: Selsey.

Remarks.—The specimen here figured was found by Mr. A. Bell many years ago at Selsey and is now in the British Museum (Nat. Hist.).

It was at first referred by him to *D. minima*, but more recently to the present species. I think with him that it is not *D. minima*. The descriptions of *D. lineolata* given by various authorities do not altogether agree. Tiberi says, for example, that the sculpture is not granulate; Locard says it is. Our St. Erth fossil appears to correspond more nearly with *D. lineolata* than with anything else I can find, and I therefore retain the name adopted for it by Mr. Bell. It is said

to be a rare form in the living state; as a fossil it has only been recorded, as far as I know, from Selsey.

It was dredged in 92 fathoms during the Porcupine Expedition on Adventure Bank at station 30.

Genus **BELA** (Leach), Gray (*continued from* p. 301).

Bela Sarsii, Verrill. Plate XXXIX, figs. 25, 26.

1878. *Bela cancellata,* G. O. Sars (non Mighels), Moll. Reg. arct. Norv., pp. 224, 361, pl. xxiii, fig. 3.

1880. *Bela Sarsii,* Verrill, Proc. U.S. Nat. Mus., vol. iii, p. 364.

1844. *Bela Sarsii,* Tryon, Man. Conch., vol. vi, p. 218, pl. xxviii, fig. 49.

1886–1901. *Bela Sarsi,* Friele, Norske Nordh. Exped. (Mollusca), pt. ii, p. 18, pl. viii, figs. 3—5, 1886; pt. iii, p. 93, 1901.

1887–1905. *Bela Sarsii,* Kobelt, Martini und Chemnitz, Conch. Cab., ed. 2, vol. iv (Pleurotomidæ), p. 147, pl. xxxi, fig. 13, 1887; Icon. schalentrag. europ. Meeresconch., vol. iii, p. 245, pl. lxxii, fig. 23, 1905.

1899. *Bela Sarsii,* Posselt, Medd. om Grønl., vol. xxiii, p. 165.

1912. *Bela Sarsi,* Dautzenberg et Fischer, Camp. scient. Pr. Monaco, vol. xxxvii (Mollusques), p. 48.

Specific Characters.—Shell small, fairly solid, fusiform, turreted; whorls 6, subscalariform, obtusely carinate below the suture, the last much the largest, about five-eighths the total length; suture deep, slightly oblique; spire attenuated; mouth ovato-oblong, nearly half the length of the shell, somewhat expanded, contracted below, angulate above; strongly sculptured with broad, thick, closely-set longitudinal ribs, not far apart, and by spiral striæ which produce rather coarse granulation when they intersect the latter; canal short, distinct.

Dimensions.—L. 8—10 mm. B. 5—6 mm.

Distribution.—*Recent:* Norwegian coast, Tromsö, Greenland, Labrador, Newfoundland.

Fossil: *Leda myalis*-bed, East Runton.

Remarks.—The fossil specimen from the Norwich Museum found in the *Leda myalis*-bed at E. Runton and figured under the present name, has been identified by Dr. Odhner, who has kindly sent me a recent shell from Finmark for comparison. It is a distinct form, easily separated from the other Crag Belas by its coarse, closely-set and nodulous costæ. The whorls are obtusely angulated above, forming a clearly-marked keel with a sloping ledge below the suture.

Among other imperfect specimens of *Bela* from the *Leda myalis*-bed at E. Runton received from my friend Mr. Kennard, I noticed some which seemed to belong to the following species, viz. *B. harpularia*, *B. mitrula*, and *B. Trevelyana*.

In a list of recent shells from the eastern coast of North America, recently published by the Boston Society of Natural History, Mr. C. W. Johnson gives the undermentioned localities for certain species of *Bela* in addition to those already recorded in this Memoir, viz. *B. exarata* as *B. concinnata* Verrill, and *B. rosea*, G. O. Sars, as well as *Buccinum perdix*, Beck, from Maine and Massachusetts, and the freshwater *Bithynia tentaculata* from Lake Champlain.[1]

Bela angulosa, Sars. Plate XXXIX, fig. 28.

1878. *Bela angulosa,* G. O. Sars, Moll. Reg. arct. Norv., pp. 227, 361, pl. xvi, fig. 16.
1887. *Bela angulosa,* Mörch and Poulsen, MS. list in the Geol. Mus. Copenhagen, no. 35 (unpublished).
1910. *Bela angulosa,* Odhner, Archiv Zool., K. Svensk. Vet.-Akad. vol. vii, no. 4, pp. 12, 24, pl. i, fig. 11, 1910; *B. cancellata* (Mighels), K. Svensk. Vet.-Akad. Handl., vol. liv, p. 213, 1915.

Specific Characters.—Shell slender, elongato-fusiform; whorls 7, convex, sharply angulated, with a sloping shelf below the suture; spire turreted, with a rather blunt apex; ornamented by strong, prominent and flexuous costæ, nodulous on the keel, crossing the shelf obliquely and reaching the suture, also by numerous fine spiral ridges; suture deep; mouth considerably less than half the total length, slightly angulated by the keel.

Dimensions.—L. 14 mm. B. 4 mm.

Distribution.—*Recent:* Finmark, Iceland, Spitzbergen, Greenland, Labrador.
Fossil: Bridlington. Iceland Crag.

Remarks.—The Bridlington fossil here figured is from the Leckenby collection at the Sedgwick Museum. It agrees very closely with the description given by Prof. Sars, and especially with the figure published by Dr. Odhner (*op. cit.*). In a letter recently received from the latter, however, he expresses the opinion that his shell may be a variety of *B. cancellata*, Mighels (non Sars). Comparing the figures of *B. cancellata* and *B. angulosa*, published by Prof. G. O. Sars, our shell corresponds most closely with that of his *B. angulosa.*

Bela borealis (Reeve). Plate XXXII, figs. 12, 13; Plate XXXIX, fig. 31.

1915. *Bela borealis,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. ii, p. 298, pl. xxxii, figs. 12, 13.

Distribution.—*Fossil:* Wexford gravels (additional).

Remarks.—Among some Belas received from Wexford since the publication of p. 298, there is one which seems to correspond more nearly with the specimen of *B. borealis* from the Iceland Crag than that there figured (*op. cit.*

[1] Bost. Soc. Nat. Hist., Occasional papers, vol. vii; Fauna of New England, pt. xiii, pp. 115, 142, 1915

fig. 12). It is specially interesting as, except for the specimen from Aldeby, this species has not been recorded hitherto from any British deposit.

I have also identified the following species of *Bela* from Wexford, viz.:

B. scalaris, Möller. *B. Trevelyana*, Turton. *B. turricula*, Montagu.

B. nobilis, Möller. *B. rugulata*, var. *Trevelyana*, *scalaroides*, G. O. Sars.

B. pyramidalis, Ström, var. *læviuscula.*—It may be interesting to notice, however, that of these *B. turricula*, a species characteristic of the later part of the Crag and of the British Pleistocene, is the most common.

Bela bicarinata (Couthouy). Plate XXXII, fig. 27; Plate XXXIX, fig. 29.

1871–84. *Pleurotoma bicarinata*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 490, 1871; in Lamplugh, vol. xl, p. 320, 1884.
1885. *Pleurotoma bicarinata*, Jeffreys in J. Starkie Gardner, Quart. Journ. Geol. Soc., vol. xli, p. 96.
1915. *Bela bicarinata*, Odhner, Kongl. Svensk. Vet.-Akad. Handl., vol. liv, p. 217.
1915. *Bela bicarinata*, F. W. Harmer, Plioc. Moll. Gt. Brit., pt. ii, p. 300, pl. xxxii, fig. 27.

Distribution.—Fossil: (additional) Iceland Crag—Husavik. Bridlington.

Remarks.—In Pl. XXXII, fig. 27, of the present work I figured a recent specimen of this species for the guidance of collectors, as the one found by Mr. A. Bell at Butley could not be traced. Since then I have received a fossil from Mr. Headley, obtained from the Bridlington drift, which corresponds with that already given. Some difference of opinion exists as to the correct nomenclature of this little shell. Dr. Odhner, accepting the specific term *bicarinata*, identifies it with *B. violacea*, while Jeffreys regarded the latter as a variety of the former. Most authorities, however, have preferred to regard the two forms as specifically distinct.

B. bicarinata was recognised by Jeffreys in 1885 among some fossils from the Pliocene deposits of Iceland which were submitted to him by Mr. J. Starkie Gardner (*op. cit.*).

Bela elegans (Möller). Plate XXXIX, fig. 27.

1842. *Defrancia elegans*, Möller, Ind. Moll. Groenl., p. 13.
1864. *Mangelia elegans*, S. P. Woodward, Geol. Mag., vol. i, p. 53.
1872. *Pleurotoma elegans*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 209, 216.
1877–84. *Pleurotoma elegans*, Jeffreys, Ann. Mag. Nat. Hist. [4], vol. xix, p. 331, 1877; in Lamplugh, Quart. Journ. Geol. Soc., vol. xl, p. 320, 1884.
1878. *Bela elegans*, G. O. Sars, Moll. Reg. arct. Norv., pp. 225, 361, pl. xvi, fig. 15.
1898. *Bela elegans*, Posselt, Medd. om Grønl., p. 151.
1910. *Bela elegans*, Odhner, Archiv Zool., K. Svensk. Vet.-Akad, vol. vii, no. 4, pp. 12, 24.

Specific Characters.—Shell slender, elongato-fusiform; whorls 7, convex, obscurely angulate with a narrow shelf below the suture; spire turreted with a

rather blunt apex; ornamented by prominent flexuous costæ, crossing the shelf obliquely and reaching the suture, and by well-marked spiral ridges; suture deep; mouth considerably less than half the total length; outer lip rounded, slightly expanded; canal short, wide and open.

Dimensions.—L. 15 mm. B. 6 mm.

Distribution.—*Recent:* Norwegian coast from the Christiania fiord to Finmark, Lofoten Islands, Iceland, Greenland, Spitzbergen.

Fossil: Bridlington.

Remarks.—This northern species was included by Jeffreys in his list of Bridlington fossils, and has been recorded also by Mr. Alfred Bell from that locality. The latter, when recently examining Mr. Headley's collection, was fortunate enough to discover Jeffreys' original specimen, unfortunately not quite perfect, with the name in the well-known writing of the latter on the box. This Mr. Headley has been kind enough to allow me to figure.

Bela multistriata (Jeffreys). Plate XXXII, fig. 29; Plate XXXIX, fig. 30.

1914. *Bela multistriata,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. ii, p. 288, pl. xxxii, fig. 29.

Remarks.—The specimen here figured, also from Mr. Headley's collection of Bridlington fossils, is rather more characteristic than the one given on my Pl. XXXII, showing the distinguishing angulation of the whorls more clearly.

Bela Trevelyana (Turton). Plate XXXII, figs. 30, 33; Plate XXXIX, fig. 32

1915. *Bela Trevelyana,* F. W. Harmer, Plioc. Moll. Gt. Brit., pt. ii, p. 294, pl. xxxii, figs. 30—33.

Distribution.—*Fossil:* Wexford gravels; *Leda myalis*-bed Runton (additional).

Remarks.—A single specimen of this widely-spread British and northern species has been obtained from the Wexford gravels. Although apparently full grown it measures only 9 mm. in length. It is a common Pleistocene shell occurring less frequently in the Crag and more generally at the newer horizons.

Genus **MERICA,** H. and A. Adams, 1853.

Merica contorta (Basterot). Plate XL, figs. 5—7.

1825. *Cancellaria contorta,* Basterot, Mém. Soc. Hist. Nat. Paris, vol. ii, p. 47, pl. ii, fig. 3.
1841. *Cancellaria contorta,* Bellardi, Descr. Canc. foss., p. 29, pl. iii, figs. 7, 8.
1856. *Cancellaria contorta,* Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 311, pl. xxxiv, figs. 7, 8.

1871. *Cancellaria contorta,* A. Bell, Ann. Mag. Nat. Hist. [4], vol. vii, p. 354.

1872. *Cancellaria contorta,* S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. i, p. 46, pl. vi, fig. 19.

1872. *Cancellaria contorta,* von Koenen, Mioc. Nord-Deutsch. Moll. Faun., pt. i, p. 25, no. 20.

1872. *Cancellaria contorta,* A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 203.

1876. *Cancellaria contorta,* Seguenza, Boll. R. Com. Geol. Ital., vol. vii, p. 8, no. 439.

1886. *Cancellaria contorta,* Dollfus et Dautzenberg, Feuilles des jeunes Nat., vol. xvi, p. 103.

1890. *Cancellaria contorta,* C. Reid, Plioc. Dep. Brit., p. 239.

1890–1904. *Cancellaria contorta,* Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 263, no. 3852, 1890; *C. (Contortia) contorta* and vars, Moll. Terr. Terz. Piem., pt. xvi, p. 49, pl. iii, figs. 24—26, 1894; *C. (Merica) contorta,* pt. xxx, p. 119, 1904.

1899. *Merica contorta,* Cossmann, Ess. Paléoconch. compar., vol. iii, p. 15.

Specific Characters.—Shell ovato-elongate; whorls convex, the last much the largest, two-thirds the total length, acuminated at the base, reticulated by fine, oblique longitudinal costæ and by raised spiral ridges; spire short, rapidly and regularly diminishing in size towards the apex; suture deep; mouth rather large, ovate; outer lip fluted within; columella contorted, with three folds.

Dimensions.—L. 18 mm. B. 10 mm.

Distribution.—Not known living.

Fossil: Lenham beds (C. Reid). Coralline Crag: Gedgrave, Boyton. Waltonian: Little Oakley.

Miocene: Touraine, south-west France, Italy, north Germany, Vienna basin.

Upper Pliocene: Bologna, Altavilla.

Remarks.—The present species, formerly grouped with *Cancellaria*, was taken in 1870 by Prof. Sacco as the type of a new sub-genus, *Contortia*, but he afterwards adopted M. Cossmann's view that it should be referred to the *Merica* of Adams.

There can be little doubt that the shells here figured as *M. contorta* agree with that reported by Wood in 1872 (*op. cit.*), though with some hesitation, under that name, an identification since adopted at Jermyn St. and at the British Museum of Natural History. They correspond fairly well with the *C. contorta* of Hörnes from the Miocene of Vienna and somewhat less closely with Prof. Sacco's figures of that species from deposits of similar age in northern Italy, but they differ considerably from Basterot's type figure. The condition of our fossils shows, I think, that they are not Miocene derivatives but true Crag forms. As *M. contorta* is reported by Seguenza, however, from the Upper Pliocene of Bologna and Altavilla, there is no valid objection to the view that it may have also existed in the Anglo-Belgian basin at the same period. My specimens present but little sign of derivation.

As I cannot find anything else with which I can satisfactorily associate our Crag shells I follow Mr. A. Bell in referring them to *M. contorta*, possibly as the northern and Pliocene equivalent of a southern and an essentially Miocene form.

Genus **BROCCHINIA,** Jousseaume, 1888.

Brocchinia mitræformis (Brocchi). Plate XXXIX, fig. 40.

1814. *Voluta mitræformis,* Brocchi, Conch. foss. subap., vol. ii, p. 645, pl. xv, fig. 13.
1841. *Cancellaria mitræformis,* Bellardi, Descr. Canc. foss., p. 9, pl. i, figs. 5, 6.
1848. *Cancellaria mitræformis,* S. V. Wood, Mon. Crag Moll., pt. i, p. 65, pl. vii, fig. 19.
1870. *Cancellaria mitræformis,* A. Bell, Journ. de Conch., vol. xviii, p. 345, no. 178.
1873. *Cancellaria mitræformis,* d'Ancona, Mem. Cart. Geol. Ital., vol. ii, p. 236, pl. xiii, fig. 7.
1874. *Cancellaria mitræformis,* Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, pp. 120, 135.
1876. *Cancellaria mitræformis,* Seguenza, Boll. R. Com. Geol. Ital., vol. vii, p. 8, no. 450.
1878. *Merica mitræformis,* de Stefani e Pantanelli, Bull. Soc. Malac. Ital., vol. iv, p. 119.
1881. *Cancellaria mitræformis,* Nyst, Conch. Terr. tert. Belg., p. 10, pl. xxviii, fig. 9.
1890–4. *Cancellaria mitræformis,* Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 264, no. 3860, 1890; *Brocchinia mitræformis,* Moll. Terr. Terz. Piem., pt. xvi, p. 68, pl. iii, figs. 81—89, 1894.
1899. *Brocchinia mitræformis,* Cossmann, Ess. Paléoconch. compar., vol. iii, p. 19, pl. i, fig. 22.

Specific Characters.—Shell rather small, slender, solid, elongato-ovate; whorls 6, slightly convex, the last two-thirds the total length; ornamented by spiral lines and sometimes by costæ, discontinuous, especially on the upper part of the shell; spire conical, elongate, ending in a blunt point; suture well-marked but not deep; mouth irregularly oval, angulate above; canal very short; outer lip grooved within; columella excavated in the middle, having two inconspicuous folds.

Dimensions.—L. 12—14 mm. B. 5—6 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Gedgrave, Gomer, Boyton. Waltonian: Walton-on-Naze, Little Oakley. Newbournian: Sutton, Newbourn, Felixstow. Scaldisien: Antwerp.

Miocene: north Germany, France, Belgium (Bolderien). Italy (Elveziano).

Lower Pliocene: Biot, Piedmont, Ligurian coast, Siena.

Upper Pliocene: Orciano, Bologna, Livorno, Altavilla.

Remarks.—The generic name *Brocchinia* is used for a special group of small Cancellariidæ of which the present species has been taken as the type. In his list of Crag shells (Quart. Journ. Geol. Soc., vol. xxvii, pp. 142, 487, 1871), and again in his paper on the Mollusca of the 'Lightning' and 'Porcupine' Expeditions (Proc. Zool. Soc., p. 49, 1885), Jeffreys identified *B. mitræformis* with a living west European shell, *Cancellaria pusilla*, H. Adams, to which it has some resemblance, but this view has not been generally accepted; one of the latest writers on the subject, Mr. E. R. Sykes, says, "I think the recent shell is distinct."[1]

It seems to be a fairly common Mediterranean fossil, ranging from the Middle Miocene to the Upper Pliocene of Italy. It occurs also at a number of Crag localities, although not very abundantly, and in the Scaldisien of Belgium. Its

[1] Proc. Malac. Soc., vol. ix, p. 332, 1911.

sculpture is rather variable, some specimens being merely spirally striated, in some the longitudinal costæ extend nearly to the base of the shell, while in others they are confined to the upper whorls. Prof. Sacco figures 9 varieties, differing in sculpture, but all maintaining the same general character.

Var. **costata,** nov. Plate XXXIX, fig. 41.

Varietal Characters.—Differs from the type form in the longitudinal costation of the whorls.

Distribution.—Fossil: Coralline Crag: Gedgrave, Boyton (A. Bell). Waltonian: Little Oakley. Newbournian: Felixstow.

Genus **SVELTIA,** Jousseaume, 1888.

Sveltia Lajonkairei (Nyst). Plate XL, figs. 18—21.

1835–81. *Cancellaria Jonkairiana,* Nyst, Rech. Coq. foss. d'Anvers, p. 29, pl. v, fig. 28, 1835; *C. varicosa,* Coq. foss. Belg., p. 475, pl. xxxviii, fig. 20, 1843; *C. Lajonkairii,* Conch. Terr. tert. Belg., p. 9, pl. i, fig. 6, 1881.
1848–50. *Cancellaria coronata,* S. V. Wood, Mon. Crag Moll., pt. i, p. 64, pl. vii, fig. 18, 1848; *C. scalaroides,* pt. ii, p. 316, pl. xxxi, fig. 9, 1850.
1856. *Cancellaria scalaroides,* Beyrich, Zeitschr. Deutsch. Geol. Gesell., vol. viii, p. 577, pl. xviii, fig. 5.
1880. *Cancellaria varicosa,* Fontannes, Moll. plioc. Vall. du Rhone, vol. i, p. 158, pl. ix, fig. 6.
1892. *Cancellaria Lajonkairei,* Van den Broeck, Bull. Soc. Belge Géol., vol. vi (Mémoires), p. 120.
1896. *Cancellaria Lajonkairi,* Bernays, Bull. Soc. Belge Géol., vol. x (Mémoires), pp. 128, 131.
1912. *Cancellaria Lajonkairei,* Tesch, Med. v. d. Rijks. v. Delfstoffen, no. 4, p. 86, no. 214.

Specific Characters.—Shell strong and solid, squarely turreted, subfusiform; whorls 7, convex, the last nearly two-thirds the total length, regularly diminishing in size upwards, obtusely angulate above, with a distinct but narrow shelf below the suture; ornamented by 9 or 10 strong lamelliform ribs, oblique or sinuous, extending to the suture and to the base of the shell and by fine spiral ridges which in specimens from the Red Crag are generally abraded or obsolete; suture deep; mouth more or less squarely angulated by the keel; outer lip grooved within; columella with two prominent folds.

Dimensions.—L. 25—42 mm. B. 8—20 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Gedgrave, Sudbourn, Boyton. Waltonian: Walton-on-Naze, Beaumont, Little Oakley. Newbournian: Waldringfield, Sutton, Foxhall. Butleyan: Butley.

Miocene: North Germany.

Pliocene: Rhone Valley. Scaldisien—zone *à Isocardia cor:* Belgium. Scaldisien: Dutch borings.

Remarks.—The generic name *Sveltia* is used for a special group of the Cancellariidæ without umbilicus, the type form being *S. varicosa*, Brocchi, described below.

Some confusion has existed as to the correct nomenclature of the present shell, which is fairly common in the Waltonian Crag at Oakley.

It was described in 1835 by Nyst (*op. cit.*) as a new species under the name of *Cancellaria Jonkairiana*, but afterwards, in 1843, identified by him with *Voluta* (*Cancellaria*) *varicosa* of Brocchi. In 1881, however, he reverted to his original determination, expressing a final opinion that it was distinct, both from the latter and from *C. coronata*, Scacchi, to which Wood had referred a similar shell, afterwards described by him as *C. scalaroides*. Wood's *C. scalaroides* and Nyst's *C. Lajonkairii* may be regarded, I think, as varieties of the same species, the principal difference between them being that the former is the more slender of the two. I agree with the authorities named that they are specifically distinct from *C. varicosa* for reasons given in the next paragraph. Both occur in the English Crag, *C. Lajonkairii* being the most abundant. I have more than 30 examples of the latter, including fragments, from Oakley. One of these I have figured, together with some specimens of it and of *S. varicosa* from several localities to show the difference between the two forms.

One specimen of the present species in the York Museum measures 42 mm. × 20 mm. Speaking generally, *S. varicosa* is a smaller and more slender shell and less strong and solid.

Sveltia varicosa (Brocchi). Plate XL, figs. 15—17.

1814. *Voluta varicosa*, Brocchi, Conch. foss. subap., vol. ii, p. 311, pl. iii, fig. 8.
1841. *Cancellaria varicosa*, Bellardi, Desc. Canc. foss. Piem., p. 11, pl. i, figs. 7, 8.
1856. *Cancellaria varicosa*, Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 309, pl. xxxiv, fig. 6.
1856. *Cancellaria varicosa*, Beyrich, Zeitschr. Deutsch. Geol. Gesell., vol. viii, p. 579, pl. xviii, fig. 6.
1871. *Cancellaria varicosa*, A. Bell, Ann. Mag. Nat. Hist. [4], vol. vii, p. 354.
1873. *Cancellaria varicosa*, d'Ancona, Mem. Cart. Geol. Ital., vol. ii, p. 227, pl. xii, figs. 7, 8.
1874. *Cancellaria varicosa*, Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, p. 120.
1876. *Cancellaria varicosa*, Seguenza, Boll. R. Com. Geol. Ital., vol. vii, p. 8, no 454.
1890–4. *Cancellaria varicosa*, Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 264, no. 3867, 1890 ; *Sveltia varicosa* and var. *simplicior*, Moll. Terr. Terz. Piem., pt. xvi, pp. 54, 55, pl. iii, figs. 42, 43, 1894.
1899. *Sveltia varicosa*, Cossmann, Ess. Paléoconch. compar., vol. iii, p. 20, pl. i, figs. 19, 20.

Specific Characters.—Differs from *S. Lajonkairei* in size and texture, in its elongate and more slender spire, and in having fewer ribs ; the transverse sculpture is finer than that shown in Wood's unworn specimen of *C. scalaroides* from the Coralline Crag (Mon. Crag Moll., pt. ii, pl. xxxi, fig. 9), with which, as just stated, I identify the first-named shell. In *S. varicosa* the whorls are more regularly convex,

rounded and depressed, not squarely angulate above—as in unworn examples of the latter from the Italian Pliocene (*cf.* fig. 15); moreover, the ribs end in an angulated row of short spines below the suture; the outer lip, which is grooved within, is gently rounded above and does not form a right angle at the upper corner of the mouth as in *S. Lajonkairei.*

Dimensions.—L. 18 mm. B. 8 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Gomer. Newbournian: Waldringfield, Felixstow.

Scaldisien: Belgium.

Miocene: north Germany, Vienna basin, Belgium (?).

Lower Pliocene: Biot, Piedmont, Ligurian coast, Tuscany.

Upper Pliocene: Bologna, Asti (abundant), Livorno, Altavilla.

Remarks.—The fossil from Waldringfield now described, belonging to the Ipswich Museum, agrees very closely with some I obtained at Asti, one of which I have figured with it. It seems to represent Prof. Sacco's variety *simplicior.* The same type occurs also in the Scaldisien of Antwerp, all of them differing from *S. Lajonkairei.* M. Van den Broeck reports *C. varicosa*, Brocchi (*C. scalaroides*, S. V. W.) from the Belgian Miocene, but to which of the two allied species given above he refers I am unable to ascertain. *S. varicosa* is a smaller species than *S. Lajonkairei* and not so strong and solid.

Genus **TRIGONOSTOMA**, Blainville, 1826.

Trigonostoma ampullaceum (Brocchi). Plate XL, fig. 1.

1814. *Voluta ampullacea,* Brocchi, Conch. foss. subap., vol. ii, p. 313, pl. iii, fig. 9.
1826. *Cancellaria ampullacea,* Risso, Hist. nat. Eur. mérid., vol. iv, p. 188, no. 482.
1841. *Cancellaria ampullacea,* Bellardi, Desc. Canc. foss. Piem., p. 35, pl. iv, figs. 7, 8.
1856. *Cancellaria ampullacea,* Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 321, pl. xxxv, fig. 4.
1872. *Cancellaria ampullacea,* d'Ancona, Mem. Cart. Geol. Ital., vol. ii, p. 211, pl. xiii, figs. 11, 12.
1874. *Cancellaria ampullacea,* Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, pp. 120, 135.
1876. *Cancellaria ampullacea,* Seguenza, Boll. R. Com. Geol. Ital., vol. vii, p. 8, no. 448.
1890–4. *Cancellaria ampullacea* and vars., Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 263, no. 3838, 1890; *C.* (*Trigonostoma*) *ampullaceum* and vars., Moll. Terr. Terz. Piem., pt. xvi, p. 9, pl. i, figs. 16—20, 1894.
1899. *Trigonostoma ampullacea,* Cossmann, Ess. Paléoconch. compar., vol. iii. p. 26.

Specific Characters.—Shell ventricose, umbilicate; whorls 5, squarely angulate above, the last much the largest, four-fifths the total length; ornamented by strong, oblique, irregular and sinuous ribs, and by fine, closely-set spiral ridges; spire short, turreted, rapidly diminishing in size towards the apex, with a wide concave shelf below the suture which is crossed obliquely by the ribs; suture deep; mouth

trigonal, angulated by the keel; outer lip crenulated, grooved within; umbilicus well marked, but not so large or deep as in *T. umbilicare;* peristome continuous; columella triplicate.

Dimensions.—L. 25—30 mm. B. 18—22 mm.

Distribution.—Not known living.

Fossil: Scaldisien: Belgium.

Miocene: France, Belgium, Germany, Vienna basin, Italy.

Lower Pliocene: Italy. Upper Pliocene: Italy, Sicily.

Remarks.—The generic (or sub-generic) name *Trigonostoma* is used for a scalaroid group of the Cancellariidæ having a sub-triangular mouth without a distinct canal, a deep umbilicus and a columella deviating upwards towards the axis of the shell, further characteristics of which have been more fully given by M. Cossmann (*op. cit.*, vol. iii, p. 24).

T. ampullaceum occurs in the Italian Pliocene, somewhat rarely in the Lower or Piacenziano deposits, but more abundantly in the Astiano. The type form has not been definitely recorded from the English Crag,[1] but one of the two specimens figured by Nyst in 1881 from the Belgian Scaldisien as *T. umbilicare* (*op. cit.*, pl. xxviii, fig. 8) may represent the present species, *T. ampullaceum*; the other (pl. i, fig. 5), being a typical example of *T. umbilicare.* As the two forms are similar in some respects, I have figured for the guidance of students a verified specimen of *T. ampullaceum* (Pl. XL, fig. 1) from Asti that I have received from my friend Prof. Sacco of Turin; this compared with a figure of *T. umbilicare* on the same plate (fig. 3), also from Asti, will show the difference between the two species.

M. Van den Broeck reports *T. ampullaceum* from the Belgian Miocene (Bolderien), and it occurs in deposits of similar age in other parts of Europe. As it seems to have been found by Nyst in the Scaldisien of Belgium, there is no reason why it should not be obtained hereafter from the English Crag.

Trigonostoma umbilicare (Brocchi). Plate XL, figs. 3, 4.

1814. *Voluta umbilicaris,* Brocchi, Conch. foss. subap., vol. ii, pp. 312, 645, pl. iii, figs. 10, 11.

1826. *Cancellaria umbilicaris,* Risso, Hist. nat. Eur. mérid., vol. iv, p. 187, no. 481.

1841. *Cancellaria umbilicaris,* Bellardi, Desc. Conch. foss. Piem., p. 35, pl. iv, figs. 17, 18.

1843–81. *Cancellaria umbilicaris,* Nyst. Coq. foss. Belg., p. 482, pl. xxxix, fig. 16, 1843; Conch. Terr. tert. Belg., p. 8, pl. i, fig. 5, 1881.

1872. *Cancellaria umbilicaris,* d'Ancona, Mem. Cart. Geol. Ital., vol. ii, p. 209, pl. xiii, fig. 10.

1874. *Cancellaria umbilicaris,* S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. ii, p. 182, Add. pl., fig. 10.

1874–92. *Cancellaria umbilicaris,* Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, p. 272, 1874; Bull. Soc. Belge Géol., vol. vi (Mémoires), p. 131, 1892.

[1] I have an imperfect and fragmentary specimen from Oakley which may possibly belong to this species.

1876. *Cancellaria umbilicaris*, Seguenza, Boll. R. Com. Geol. Ital., vol. vii, p. 8, no. 449.

1878. *Trigonostoma umbilicaris*, de Stefani e Pantanelli, Bull. Soc. Malac. Ital., vol. iv, p. 115.

1890–4. *Cancellaria umbilicaris* and vars., Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 264, no. 3865, 1890; *C.* (*Trigonostoma*) *umbilicare* and vars., Moll. Terr. Terz. Piem., pt. xvi, p. 4, pl. i, figs. 4—6, 1894.

1896. *Cancellaria umbilicaris*, Bernays, Bull. Soc. Belge Géol., vol. x (Mémoires), p. 131.

1899. *Trigonostoma umbilicaris*, Cossmann, Ess. Paléoconch. compar., vol. iii, p. 25, pl. ii, figs. 1, 2.

1912. *Cancellaria umbilicaris*, Tesch, Med. v. d. Rijks. v. Delfstoffen, no. 4, p. 86, no. 216.

Specific Characters.—Shell strongly and deeply umbilicate; whorls scalariform, compressed below, deeply excavated above with a concave shelf below the suture, crossed obliquely by the ribs; the last ventricose, much the largest; ornamented by oblique or flexuous longitudinal costæ, ending in more or less clearly-marked, recurved spines and crossed by spiral ridges; spire short, rapidly diminishing in size upwards, ending in a blunt point; mouth triangular; peristome continuous; umbilicus wide, deep and open, extending to the upper end of the spire; columella with two strong folds and a smaller one below.

Dimensions.—Of the Crag specimen, L. 22 mm. B. 15 mm.

Distribution.—Not known living.

Fossil: Newbournian Crag: Waldringfield.

Scaldisien: Antwerp, Dutch borings.

Italian Pliocene: Piacenziano (rare). Astiano: Asti (abundant). Sicily—Altavilla.

Remarks.—This species, which is exceedingly common in the Upper Pliocene at Asti where I found one of the specimens here figured, may be distinguished from the one last described by its open and deep umbilicus which penetrates to the apical end of the spire. Except that the Crag specimen, which is from the Canham collection in the Ipswich Museum, is rather shorter than the Asti fossil, it corresponds very closely with it. The former is but little worn, and as *T. umbilicare* is characteristic of the Upper Pliocene of Italy there seems no necessity for regarding it as derivative in the Crag. Dr. Tesch informs me, moreover, that he has obtained 5 typical examples of it from beds he regards as Scaldisien in a boring at Grave-Oss in North Brabant, and M. Bernays reports it from deposits of similar age at Antwerp. The fossil from Waldringfield figured by Wood (*op. cit.*) is, I consider, the true *T. umbilicare.*

Sub-genus **VENTRILIA**, Jousseaume, 1888.

Trigonostoma (Ventrilia) acutangulum (Faujas-de-Saint-Fond). Plate XL, fig. 2.

1817. *Cancellaria acutangula*, Faujas-de-Saint-Fond, Mém. Mus. Hist. Nat. Bordeaux, vol. iii, pl. x, fig. 1.

1825. *Cancellaria acutangula*, Basterot, Mém. Soc. Hist. Nat. Paris, vol. ii, p 45, pl. ii, fig. 4.

1840. *Cancellaria acutangula* and vars., Grateloup, Conch. foss. Terr. tert. Bass. del' Adour, vol. i (Cancellaria), pl. i, figs. 1—4.
1890–94. *Cancellaria acutangula,* Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 263, no. 3844, 1890; *C.* (*Gulia*) *acutangula* and vars., Moll. Terr. Terz. Piem., pt. xvi, p. 21, pl. ii, figs. 1—4, 1894.
1899. *Trigonostoma* (*Ventrilia*) *acutangula,* Cossmann, Ess. Paléoconch. compar., vol. iii, p. 27, pl. i, figs. 12—14.

Specific Characters.—Shell large, ovate, sub-umbilicate; whorls 5 or 6, sub-ventricose, angulated above, with a square shelf below the suture, the last much the largest; spire short, rapidly diminishing upwards; ornamented by longitudinal costæ, oblique and irregular, not very prominent, denticulated on the keel, and by inconspicuous spiral ridges; mouth large, trigonal, angulated below; outer lip sharply angulated at the upper right-hand corner, grooved internally; inner lip reflected on the columella, expanded upwards; columella indistinctly triplicate.

Dimensions.—L. 36 mm. B. 24 mm.

Distribution.—Not known living.

Fossil: Red Crag, probably Newbournian and derivative.

Miocene: Piedmont, Aquitaine, Anjou.

Remarks.—The specimen figured under this name belongs to the Sedgwick Museum at Cambridge, where it has been labelled Red Crag, Suffolk; it may probably have been obtained from the Newbournian horizon of the Waldringfield district which has yielded a number of specimens believed by Wood to be derivative.

It appears to belong to the sub-genus *Ventrilia* (*Gulia* of Sacco[1]) of which our Crag fossil, which I refer to the species *acutangulum,* has been taken as the type. It is a characteristic Miocene shell known from south-west France, Piedmont and possibly from the Vienna basin.

Genus **BONELLITIA,** Jousseaume, 1888.

Bonellitia evulsa (Solander). Plate XL, figs. 12—14.

1766. *Buccinum evulsum,* Solander in Brander, Foss. Hant., p. 13, pl. i, fig. 14.
1823. *Cancellaria evulsa,* J. Sowerby, Min. Conch., vol. iv, p. 84, pl. ccclxi, figs. 2—4.
1843. *Cancellaria evulsa,* Nyst, Coq. foss. Terr. tert. Belg., p. 477, pl. xxxix, fig. 13.
1856. *Cancellaria evulsa,* Beyrich, Zeitschr. Deutsch. Geol. Gesell., vol. viii, p. 556, pl. xvii, figs. 2—5.
1856. *Cancellaria Bellardii,* Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 314, pl. xxxiv, figs. 17, 18.
(?) 1867. *Cancellaria evulsa,* Speyer, Palaeontographica, vol. xvi, p. 177, pl. xvi, figs. 1—4.
1874. *Cancellaria Bellardi,* Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, pp. 120, 135.
1889. *Cancellaria evulsa,* von Koenen, Abh. geol. Specialk. Preussen, vol. x, p. 117, pl. x, figs. 1—3.

[1] M. Cossmann considers the terms *Gulia* and *Ventrilia* synonymous, preferring the use of the latter.

1890–4. *Cancellaria Bellardii*, Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 263, no. 3840, 1890; *Bonellitia evulsa* and vars., Moll. Terr. Terz. Piem., pt. xvi, p. 45, pl. iii, figs. 12—20, 1894.
1899. *Admete (Bonellitia) evulsa*, Cossmann, Ess. Paléoconch. compar., vol. iii, p. 33, pl. ii, figs. 6, 7.
1907. *Cancellaria evulsa*, Ravn, Kongl. Dansk. Vid.-Selsk. Skrift. [7], vol. iii, p. 339, pl. vi, fig. 16.
1913. *Cancellaria evulsa*, Harder, Danm. geol. Undersøgelse [2], no. 22, pp. 85, 130, pl. vii, figs. 4, 5.

Specific Characters.—Shell of moderate size, ovato-oblong; whorls 6, convex, the last ventricose, much the largest, three-fourths the total length, excavated below; ornamented by numerous oblique longitudinal costæ, with an occasional varix, and by fine spiral lines which cross the ribs; suture deep; spire rapidly and regularly diminishing in size upwards; mouth irregularly ovate, angulated above and below; outer lip thickened and grooved within; columella with three folds.

Dimensions.—(Of Crag specimens) L. 12—15 mm. B. 7—10 mm.

Distribution.—Not known living.

Fossil: Waltonian Crag: Little Oakley.

Eocene: Hampshire basin, France, Denmark, Belgium.

Oligocene: Germany (Upper, Middle, and Lower). Denmark (Upper and Middle), Belgium.

Miocene: Denmark, Belgium, Vienna basin, Italy.

Remarks.—The generic name *Bonellitia* is used for a group of the Cancellariidæ allied to *Admete* but differing from the latter in certain particulars which are given, with a full statement of its distinguishing characteristics, by M. Cossmann in the work already alluded to.

The present species, originally described from an Eocene fossil of the Hampshire basin, has been recorded from various horizons of the Oligocene and Miocene deposits of different parts of Europe, in which it is widely distributed. Specimens from the Eocene are not identical with those of a later period, but they are all grouped by palæontologists as varieties of the same species. *B. evulsa* continued to exist in the North Sea basin up to and during Miocene times, but it has not been recorded hitherto from the Crag. Its variable character is shown by the fact that Prof. Sacco has described 9 distinct varieties of it, mostly from the neighbourhood of Turin.

I figure a specimen from the Belgian Miocene received from M. Dautzenberg which he considers to represent one of Prof. Sacco's varieties of this species.[1] I have found several examples at Oakley, more or less imperfect and smaller, apparently belonging to the same group.

M. Cossmann while separating this and some allied forms from *Cancellaria*, regards *Bonellitia* as a sub-genus of *Admete.*

[1] Our Crag shells agree with the Miocene rather than with the Eocene form.

Bonellitia serrata (Bronn). Plate XL, figs. 10, 11.

1831. *Cancellaria serrata*, Bronn, Ital. Tert. Geb., p. 44, no. 211.
1872. *Cancellaria Bellardi ?*, S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. 1, p. 47, pl. iii, fig. 25.
1873. *Cancellaria serrata*, d'Ancona, Mem. Cart. Geol. Ital., vol. ii, p. 232, pl. xiii, figs. 13, 14.
1876. *Cancellaria serrata*, Seguenza, Boll. R. Com. Geol. Ital., vol. vii, p. 8, no. 452.
1890–4. *Cancellaria serrata*, Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 264, no. 3863, 1890; *Bonellitia serrata*, Moll. Terr. Terz. Piem., pt. xvi, p. 43, pl. iii, figs. 5—10, 1894.
1899. *Admete* (*Bonellitia*) *serrata*, Cossmann, Ess. Paléoconch. compar., vol. iii, p. 34

Specific Characters.—Shell small, fragile, ovato-turriculate; whorls 5 or 6, ventricose and rounded, the last much the largest, about two-thirds the total length; ornamented by numerous obliquely curved longitudinal costæ, distinct but not prominent, clathrated by fine well-marked spiral ridges with still finer ones in the interspaces; spire rapidly diminishing in size upwards; suture deep; mouth oval; outer lip grooved within; columella imperforate, with three folds.

Dimensions.—L. 10 mm. B. 7 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Boyton. Waltonian: Little Oakley. Newbournian: Sutton (? derivative).

Miocene: France, Italy.

Lower Pliocene: Castelnuovo, Ventimiglia, Bordighera, Albenga.

Upper Pliocene: Livorno, Bologna, Orciano, Altavilla.

Remarks.—The present species is said to occur abundantly at certain localities of the *argiles bleues* (Lower Pliocene) of the Ligurian coast, and Seguenza gives it from various exposures of the Upper Pliocene of Sicily and Italy. One of the specimens now represented is from the Coralline Crag of Boyton and belongs to the Sedgwick Museum at Cambridge; the Italian fossil figured for comparison, with which it closely corresponds, I owe to the kindness of Mr. Clarence Bicknell of Bordighera. I have two others from Oakley, imperfect, which Prof. Sacco has identified with them; the one given by Wood as *C. Bellardi*, from the Red Crag of Sutton, was regarded by the latter as derivative from some older deposit, which, judging from its appearance, may probably be the case. That from Boyton, however (fig. 10), is clearly a genuine Crag shell.

Prof. Sacco remarks that *B. serrata*, though varying in the number and size of its longitudinal and transverse costæ, retains a character of its own which is sufficiently constant. It seems specially distinguished by its delicate sculpture and its ventricose whorls.

Bonellitia granulata (Nyst). Plate XL, fig. 8.

1843. *Cancellaria granulata,* Nyst, Coq. foss. Terr. tert. Belg., p. 479, pl. xxxix, fig. 14.
1856. *Cancellaria granulata,* Beyrich, Zeitschr. Deutsch. Geol. Gesell., vol. viii, p. 567, pl. xvii, figs. 7—9.
1867. *Cancellaria granulata,* Speyer, Palaeontographica, vol. xvi, p. 179, pl. xvi, figs. 6—8.
1913. *Cancellaria granulata,* Harder, Danm. geol. Undersøgelse [2], no. 22, p. 86, pl. vii, fig. 10.

Specific Characters.—Shell solid, elongato-ovate, turreted; whorls 6 or 7, convex, the last about five-eighths of the total length; ornamented by about a dozen strong and somewhat oblique longitudinal costæ, nearly equal to the interspaces, and by rather strong spiral ridges which cause granulation where they intersect the ribs; spire regularly diminishing in size towards an obtuse apex; suture well-marked; mouth oval, angulate above; columella with three folds; canal very short.

Dimensions.—L. 17 mm. B. 9 mm.

Distribution.—Not known living.

Fossil: Newbournian Crag: Bentley, probably derivative.

Upper Oligocene: north Germany. Middle Oligocene: Denmark.

Remarks.—The fossil here figured was found among some Crag material from Bentley received from my friend Prof. P. G. H. Boswell. Although not quite perfect it shows clearly its original form and sculpture. It approaches an Oligocene shell described by Nyst in 1843 as *Cancellaria elongata* (Coq. foss. Terr. tert. Belg., p. 476, pl. xxxviii, fig. 21), as to which Wood states he had found in the Coralline Crag an imperfect specimen which somewhat resembled it. The Bentley shell appears, however, to differ materially, both in form and sculpture, from the one described by Nyst under that name, and I am disposed rather to refer it, at least provisionally, to another Oligocene species, *B. granulata,* with which I think it more nearly agrees. In any case our fossil is probably derivative in the Crag. In endeavouring to identify our Crag specimens with those of other times and other regions we may remember, first, that many species are very variable, and next, that one cannot place implicit reliance on non-photographic figures. This may be illustrated by a comparison of those of the present species given by the three authors mentioned above.

Bonellitia incerta, sp. nov. Plate XL, fig. 9.

Specific Characters.—Shell minute, fragile; whorls 4, convex, the last tumid, much the largest, two-thirds the total length; ornamented by rather distant costæ, not so wide as the spaces between them, and by clearly marked spiral ridges; spire short, truncated, ending abruptly in a very small apex; suture deep; mouth

wide, oval; outer lip expanded with a thin edge, but strengthened behind by the last rib and continuous with a short canal; columella with two distinct folds.

Dimensions.—L. 6 mm. B. 3 mm.

Distribution.—Not known living.

Fossil: Gedgravian Crag: Gedgrave.

Remarks.—This minute shell is from the Wood Collection at the Norwich Castle Museum. It seems to belong to the *serrata* group, but I do not think it can be regarded as a variety of that species. As I cannot find anything to which I may satisfactorily refer it, I describe it provisionally under the above name. In form and size it approaches an Antwerp fossil, *C. minuta*, Nyst (Coq. foss. Terr. tert. Belg., p. 482, pl. xxxviii, fig. 23, 1843), but, if we may depend on the correctness of Nyst's figure, the sculpture of that species is much finer and more delicate.

Genus **ADMETE**, Kröyer, 1842.

Admete viridula (Fabricius). Plate XXXIX, figs. 42—47.

1780. *Tritonium viridulum*, Fabricius, Faun. Groenl., p. 402.
1818. *Murex costellifer*, J. Sowerby, Min. Conch., vol. ii, p. 225, pl. cxcix, fig. 3.
1846. *Cancellaria viridula*, Lovén, K. Svensk. Vet.-Akad. Förh., vol. iii, p. 87.
1848–74. *Cancellaria costellifera*, S. V. Wood, Mon. Crag Moll., pt. i, p. 66, pl. vii, fig. 24, 1848; *C.* (*Admete*) *viridula*, 1st Suppl., pt. ii, p. 206, 1874.
1869–71. *Admete viridula*, Jeffreys, Brit. Conch., vol. v, p. 216, 1869; in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, pp. 142, 487, 1871.
1872. *Admete viridula*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 203, 209, 213, 215.
1874–92. *Cancellaria viridula*, Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, p. 292, 1874; Bull. Soc. Belge Géol., vol. vi (Mémoires), p. 121, 1892.
1878. *Admete viridula*, G. O. Sars, Moll. Reg. arct. Norv., pp. 216, 361, pl. xiii, fig. 1 *a*; var. *producta*, p. 217, pl. xiii, fig. 2.
1881. *Cancellaria* (*Admete*) *viridula*, Nyst, Conch. Terr. Tert. Belg., p. 11, pl. i, fig. 7.
1887. *Admete viridula*, Mörch and Poulsen, MS. list in Geol. Museum, Copenhagen, no. 30 (unpublished).
1887. *Admete viridula*, Kobelt, Martini und Chemnitz, Conch. Cab., ed. 2, vol. iv (*Cancellaria*), p. 98.
1890. *Cancellaria viridula*, C. Reid, Plioc. Dep. Britain, p. 240, pl. iv, fig. 4.
1899. *Admete viridula*, Posselt, Medd. om Grønl., vol. xxiii, p. 166.
1899. *Cancellaria viridula*, Locard, Coq. mar. Côtes de France, p. 54.
1901. *Admete viridula*, Brøgger, Norg. geol. Undersøgelse, no. 31, p. 653, pl. ii, fig. 4.
1910–15. *Admete viridula*, Odhner, Archiv Zool., K. Svensk. Vet.-Akad., vol. vii, no. 4, p. 24, 1910; K. Svensk. Vet.-Akad. Handl., vol. liv, p. 207, 1915.
1912. *Cancellaria viridula*, Tesch. Med. v. d. Rijks. v. Delfstoffen, no. 4, p. 86, no. 215.
1912. *Admete viridula* and vars., Dautzenberg et Fischer, Camp. scient. Pr. Monaco, vol. xxxvii (Mollusques), p. 55.[1]
1915. *Admete viridula*, A. Bell, Geol. Mag. [6], vol. ii, p. 168.

[1] MM. Dautzenberg and Fischer, in the above-named work, gave a list of more than 100 references to the present species and its varieties.

Specific Characters.—Shell fairly solid, ovato-fusiform; whorls about 7, convex, the last more or less ventricose, excavated below; varying considerably in sculpture, generally ornamented by prominent oblique and obtuse longitudinal costæ which die out on the body-whorl, and always by irregular spiral ridges which extend to the base; spire elongato-conical, ending in a fine rounded apex; suture deep; mouth oval, passing into a short and narrow canal; outer lip thin; folds on the columella obscurely triplicate.

Dimensions.—L. 12—18 mm. B. 6—10 mm.

Distribution.—*Recent:* (with varieties) Hebrides (Jeffreys), Scilly (Marshall), Brittany (Locard). Norwegian Coast—Trondhjem to Finmark, Lapland, Lofoten Islands. Iceland, Barent's Sea, Spitzbergen, Greenland, Labrador, Hudson's Bay, Davis Strait, New England coast, Behring Strait.

Fossil: Coralline Crag: Sutton, Gedgrave, Sudbourn. Waltonian: Walton-on-Naze, Little Oakley. Newbournian: Waldringfield, Sutton, Newbourn, Felixstow. Butleyan: Bawdsey, Hollesley, Butley. Icenian: Norwich zone—Bramerton, Postwick, Aldeby, Dunwich, Horsford. Weybourne zone—E. Runton. Iceland Crag. Wexford, Isle of Man.

Scaldisien, Poederlien: Antwerp. Dutch borings.

Pleistocene: Bridlington, Dimlington, west Cheshire, Cleongart. Christiania fiord, from *Yoldia*-clays to *Tapes*-banks. Montreal.

Remarks.—This species, which with its varieties seems to be almost entirely confined at present to northern and arctic seas, made its first recorded appearance in the Anglo-Belgian region in Coralline Crag times; it is not very rare in the Waltonian of Oakley, and is generally diffused at the later horizons of the Red and the Icenian deposits. It is given by Prof. Kendall from the Manx beds and by Mr. A. Bell from Wexford, occurring also at Bridlington and other Pleistocene localities. I have found several varieties at Oakley, one corresponding with Prof. G. O. Sars' type form (*op. cit.*, pl. xiii, fig. 1 *a*), and another with his variety *producta* (fig. 2). The Crag specimens in my collection, which I group with the type variety, have an elongate spire—indeed, Wood's description (*spirâ acuminatâ*) makes this feature specially characteristic. There is another group, described below, with a short spire and a more or less ventricose body-whorl which may be known, I think, as varietal under Jay's name of *Couthouyi*. The Conchological Society of Great Britain, however, in their list of British Marine Mollusca, have united the latter with *A. viridula* as one species, *A. Couthouyi*.

Var. **Couthouyi** (Jay). Plate XXXIX, figs. 48, 49.

1838. *Cancellaria buccinoides*, Couthouy,[1] Boston Journ. Nat. Hist., vol. ii, p. 105, pl. iii, fig. 3.
1839. *Cancellaria Couthouyi*, Jay, Cat. of Shells, p. 77.

[1] The specific name *buccinoides* had been used previously, in 1832, by Sowerby, for a different and North American shell.

1841–70. *Cancellaria Couthouyi*, Gould, Inv. Mass., ed. 1, p. 283, fig. 190, 1841; *C. viridula*, ed. 2, p. 391, fig. 652, 1870.

1849. *Cancellaria (Tritonium) viridula*, var. A[1], aa, Middendorff, Mém. Acad. Imp. Sci., St. Petersbourg [6], vol. vi, p. 439, pl. x, figs. 1, 2.

1871. *Cancellaria Couthouyi*, A. Bell, Ann. Mag. Nat. Hist. [4], vol. vii, p. 354.

1872. *Cancellaria (Admete) viridula*, var. *Couthouyi*, S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. i, p. 97, pl. vi, fig. 12.

1872. *Admete viridula*, Dawson, Canadian Nat. (n.s.), vol. vi, p. 396, pl. vi, fig. 7.

1872. *Admete Couthouyii*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 209.

1876. *Admete undato-costata*, Verkrüzen in Kobelt, Jahr. malak. Ges., vol. iii, p. 372, pl. iv, fig. 6.

1878. *Admete viridula*, var. *undato-costata*, G. O. Sars, Moll. Reg. arct. Norv., p. 217, pl. xiii, fig. 16.

1886. *Admete viridula*, Friele, Norske Nordh. Exped. (Mollusca), pt. ii, p. 24, pl. viii, figs. 27–30.

1887. *Admete viridula*, var. *abnormis*, Mörch and Poulsen, MS. list and Plates in Geol. Mus., Copenhagen, no. 31, pl. iv, fig. 10 (unpublished).

1915. *Admete Couthouyi*, Johnson, Bost. Soc. Nat. Hist., Occas. papers, vol. vii; Faun. of New Engl., pt. xiii (Mollusca), p. 140.

Varietal Characters.—Differs from *A. viridula* in its shorter spire, its ventricose body-whorl and sometimes in its finer and ecostate sculpture.

Distribution.—Recent: Arctic and North American, from Siberia to the New England coast.

Fossil: Coralline Crag: Boyton. Newbournian: Waldringfield. Butleyan: Butley. Iceland Crag.

Pleistocene: Bridlington, Montreal.

Remarks.—In his 1st supplement of 1872 (*op. cit.*) Wood figured a specimen of *Admete* from Butley which had been identified by Mr. Bell with the American *A. Couthouyi* of Jay. It had a shorter spire, more tumid whorls, and finer sculpture than the typical *A. viridula*, corresponding closely with Verkrüzen's var. *undato-costata* of that species, figured and described by Prof. G. O. Sars in 1878, which was said to be ventricose with a short spire.

There is a specimen at Jermyn Street which I am permitted to figure, belonging to the same group but without the longitudinal costæ of the Butley shell. In the latter respect this agrees with an example of *A. viridula* represented by Middendorff, and to a somewhat less extent with another given by the late Sir J. W. Dawson (*op. cit.*) from the Pleistocene of Montreal.

Taken as a whole they seem to be distinct from the typical *A. viridula*, having a general relation to one another and to the American *A. Couthouyi*. Following Wood, therefore, I retain the latter for them as a varietal name.

The specimen figured by Mörch and Poulsen as *A. viridula*, var. *abnormis* (*op. cit.*) seems to be the same as our shell.

Sub-genus **BABYLONELLA**, Conrad, 1865.

Admete (Babylonella) subangulosa (S. V. Wood).

1842–48. *Cancellaria subangulosa*, S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix, p. 538, 1842; Mon. Crag Moll., pt. i, p. 66, pl. vii, fig. 20, 1848.
1871. *Cancellaria subangulosa*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 142.
1890. *Cancellaria subangulosa*, C. Reid, Plioc. Dep. Brit., p. 240.
1899. *Admete* (*Babylonella*) *subangulosa*, Cossmann, Ess. Paléoconch. compar., vol. iii, p. 36.

Specific Characters.—Shell minute, ovato-fusiform; whorls 5—6, slightly convex, obtusely angulate below the suture, the last much the largest; spire elevated, regularly tapering; apex acute; suture rather deep; ornamented by numerous very fine and indistinct costæ, intersected by minute spiral striæ; mouth ovate, angulated by the keel; outer lip thin; inner lip reflected; canal very short; umbilicus small, open; 3 minute inconspicuous folds on the columella.

Dimensions.—L. 6 mm. B. 2 mm.

Distribution.—Not known living (?).

Fossil: Coralline Crag: Sutton.

Remarks.—This species is very rare in the English Crag, a few specimens only having been obtained from the Coralline horizon at Sutton. Messrs. Dautzenberg and Fischer report an angulated variety of *A. viridula* dredged off the Norwegian coast at a depth of 440 m., which they consider the equivalent of our shell, and Jeffreys states (*op. cit.*) that the latter has been obtained in the West European region, though without giving any particulars. His views as to the identification of our Crag shells with recent species, however, have not been always accepted.

Unfortunately Wood's specific name of *subangulosa* was adopted by von Koenen and by Speyer for a north German Oligocene fossil, and in this they have been followed by other Continental authorities, the latter form being grouped with *C. pusilla*, Phil., *C. Nysti*, Hörnes, *C. minuta*, Braun, and *C occulta*, Beyr., all characteristic forms of the Oligocene of central Europe. The figures given by the authors referred to differ so materially from the type forms of the Crag *A. subangulosa* that, apart from the improbability of the latter being identical with an Oligocene species, I am more than doubtful whether they are the same. M. Cossmann, moreover, is of this opinion. Speaking of von Koenen's Oligocene *C. subangulosa*, he says it is "*évidemment distincte*."[1]

Admete (Bablyonella) Reedii (A. Bell).

1870. *Admete Reedii*, A. Bell, Ann. Mag. Nat. Hist. [4], vol. iv, p. 214.
1872. *Cancellaria subangulosa*, S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. i, p. 47, pl. iii, fig. 27.
1872. *Admete Reedi*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 203.

[1] *Op. cit.*, vol. iii, p. 36.

Specific Characters.—Shell ovately fusiform, larger than *A. subangulosa;* whorls 6—7, obtusely angulate towards the top forming a shoulder, finely striated; costæ hardly perceptible (A. Bell); spire tapering; suture slight; inner lip reflected; plaits on the columella indistinct.

Dimensions.—L. 15 mm. B. 6 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Gomer pit.

Remarks.—This form was described by Mr. Bell in 1870 as a new species from one or two specimens he had found at the Gomer pit, near Oxford. It was afterwards figured by Wood as identical with the minute shell last described as *C. subangulosa.* Mr. Bell, however, still considers them distinct. I have not the material enabling me to express any opinion of my own, but in view of the doubt as to whether either of them can be regarded as the equivalent of the Oligocene fossil alluded to above, it may be well to keep the matter alive for further consideration.

Admete (Babylonella) gracilenta (S. V. Wood). Plate XXXIX, figs. 51, 52.

1872. *Cancellaria (Admete) gracilenta,* S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. i, p. 46, pl. iii, fig. 23.
1890. *Cancellaria gracilenta,* C. Reid, Plioc. Dep. Brit., p. 239.
1912. *Admete (Babylonella) gracilenta,* Cossmann, Ess. Paléoconch. compar., vol. iii, p. 36.

Specific Characters.—Shell small, ovate, narrowed at both ends; whorls 6, convex; ornamented by numerous fine, rather inconspicuous costæ, intersected and decussated by fine spiral ridges; suture fairly deep; mouth oval; outer lip thin, rounded, somewhat expanded; inner lip reflected on the pillar with a small umbilicus; columella with three inconspicuous folds.

Dimensions.—L. 10—15 mm. B. 6—9 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Sutton, Boyton, Ramsholt. Waltonian: Little Oakley.

Remarks.—The form represented under the above name was first considered by Wood as a variety of *Admete viridula,* but was afterwards described by him as specifically distinct, a view accepted by M. Cossmann, who includes it in the subgenus *Babylonella.*

Admete (Babylonella) Wouweri, sp. nov. Plate XXXIX, fig. 50.

Specific Characters.—Shell small, slender, fragile; whorls convex, the last two-thirds the total length; ornamented by excessively fine and closely-set spiral

ridges which reach the sutures and the base of the shell, and by numerous inconspicuous lines of growth; suture fairly deep; spire regularly tapering upwards to a sharp point; mouth ovate, angulated above; outer lip thin, gently curved and slightly expanded; folds on the columella well marked.

Dimensions.—L. 10 mm. B. 5 mm.

Distribution.—Not known living.

Fossil: Scaldisien: Antwerp.

Remarks.—When making a rapid and as I hoped a preliminary examination of the interesting collection of Belgian fossils accumulated by M. van de Wouwer of Antwerp, he was good enough to allow me to select several specimens of what I believe to be an undescribed form of *Admete* allied to *A. gracilenta* but sufficiently distinct to be regarded as a new species. I am afraid to think what my good friend may have suffered during the occupation of his country by its pitiless foes. I can only dedicate this charming little shell to him in grateful recognition of his zeal as a student of the Antwerp Crag and of the kind assistance he so willingly rendered me during my visits to Antwerp. I have met with no trace of this form in the Waltonian deposits, but it may turn up in them hereafter. In sculpture, though not altogether in form, it resembles a species described by Mr. Friele as new under the name of *A. inflata* (*op. cit.*, pt. ii, p. 25, pl. viii, fig. 33).

Genus **POTAMIDES**, Brongniart, 1810.

Sub-genus **PTYCHOPOTAMIDES**, Sacco, 1895.

Potamides (Ptychopotamides) tricinctus (Brocchi). Plate XL, figs. 23—25.

1814. *Murex tricinctus*, Brocchi, Conch. foss. subap., vol. ii, p. 446, pl. ix, fig. 23.

1842–72. *Cerithium punctatum*, S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix, p. 537, 1842; *C. tricinctum*, Mon. Crag Moll., pt. i, p. 69, 1848; 1st Suppl., pt. i, p. 51, pl. iii, fig. 19, 1872.

1870. *Cerithium tricinctum*, S. V. Wood, Jr., and F. W. Harmer, Rep. Brit. Assoc. (Liverpool), Trans. Sect., p. 90.

1871. *Cerithium tricinctum*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 487.

1872. *Cerithium tricinctum*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 203, 209.

1874–92. *Cerithium tricinctum*, Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, pp. 272, 280, 285, 1874; vol. xiv, p. 76, 1879; vol. xvii, p. 204, 1882; Bull. Soc. Belge Géol., vol. vi (Mémoires), p. 123; *C. (Potamides) tricinctum*, p. 133, 1892.

1875. *Cerithium tricinctum*, Seguenza, Boll. R. Com. Geol. Ital., vol. vi, p. 344, no. 418.

1878. *Potamides tricinctum*, de Stefani e Pantanelli, Bull. Soc. Malac. Ital., vol. iv, p. 159.

1881. *Cerithium tricinctum*, Nyst, Conch. Terr. Tert. Belg., p. 79, pl. vi, fig. 10.

1890. *Cerithium tricinctum*, C. Reid, Plioc. Dep. Brit., pp. 53, 241.

1890–5. *Potamides tricinctus*, Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 190, no. 2125, 1890; *P. (Ptychopotamides) tricinctus* and vars., Moll. Terr. Terz. Piem., pt. xvii, p. 44, pl. iii, fig. 8, 1895.

1898–1915. *Cerithium tricinctum*, A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 143, 1898; Geol. Mag. [6], vol. ii, p. 167, 1915.

1906. *Potamides (Ptychopotamides) tricinctus*, Cossmann, Ess. Paléoconch. compar., vol. vii, p. 106.

1912 *Cerithium tricinctum*, Tesch, Med. v. d. Rijks. v. Delfstoffen, no. 4, p. 76, no. 179.

1916. *Ptychopotamides tricinctus*, R. B. Newton, Journ. of Conch , vol. xv, pp. 70, 111, pl. iii, fig. 3.

Specific Characters.—Shell turreted, strong in the type form; whorls 10 or 12, the upper ones flattened, the lower ones becoming more or less convex, the base being rounded and covered with well-marked spiral, non-granulate ridges; ornamented by three closely set rows of tubercles, connected both transversely and longitudinally; spire long and subulate; suture fairly deep, slightly channelled, with a fine spiral ridge above it; mouth sub-circular; canal short and narrow.

Dimensions.—L. 40—54 mm. B. 13—16 mm.

Distribution.—Not known living.

Fossil: Lenham. St. Erth. Coralline Crag: Sutton, Orford district, Boyton. Red Crag: Waltonian, Newbournian, Butleyan, Icenian. Isle of Man.

Miocene: Italy, France.

Lower Pliocene: Italy.

Upper Pliocene: Italy, Belgium, Holland.

Var. **inornata** (S. V. Wood, MS., *fide* Van den Broeck). Plate XL, fig. 22.

1848. *Cerithium tricinctum*, S. V. Wood, Mon. Crag Moll., pt. i, p. 69, pl. viii, figs. 1 *b*, 2.

1882–92. *Cerithium tricinctum*, var. *inornata*, Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. xvii, p. 204, 1882; Bull. Soc. Belge Géol., vol. vi (Mémoires), p. 145, 1892.

1895. *Potamides (Ptychopotamides) tricinctus*, var. *subagranosa*, Sacco, Moll. Terr. Tert. Piem., pt. xvii, p. 44, pl. iii, fig. 9.

Varietal Characters.—Shell usually larger than the type, whorls more distinctly convex, sometimes with 4 or 5 spiral ridges non-granulate, or but obscurely so; suture deeper.

Dimensions.—L. 60 mm. B. 18 mm.

Distribution.—Red Crag: Waltonian, Newbournian, Butleyan, unrecorded from the Icenian.

Var. **icenica**, nov. Plate XL, fig. 26.

1833. *Cerithium punctatum*, S. Woodward, Geol. of Norfolk, p. 44, pl. iii, fig. 29.

1848. *Cerithium tricinctum*, S. V. Wood, Mon. Crag Moll., pt. i, p. 69, pl. viii, fig. 1 *a*.

1864. *Cerithium punctatum*, S. P. Woodward, in White's Hist. of Norfolk, ed. 3, p. 118.

1872. *Cerithium tricinctum*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 209, 213.

Varietal Characters.—Shell conical, with flattened whorls and a subangulate base, smaller and more fragile in the Icenian than in the typical Red Crag form; granulate sculpture more distinct.

Dimensions.—L. 25—32 mm. B. 9—10 mm.

Distribution.—*Fossil:* Icenian Crag, locally abundant.

Remarks.—*Potamides tricinctus*, with its varieties, was regarded by Wood, and in 1881 by Nyst[1] as the equivalent of the *Murex tricinctus* of Brocchi. It is now included by M. Cossmann in the *Ptychopotamides* of Prof. Sacco, a sub-genus of *Potamides.*

The type form (figs. 23—25) is strong and solid; it is fairly common in the Waltonian zone, as at Oakley, becoming less so at the later horizons of the Red Crag, while it disappeared from the Anglo-Belgian basin during the Icenian period.

The variety *inornata*, also a Red Crag form, resembles more or less nearly the variety *subagranosa* of Sacco, an Astian shell, as to which he remarks that occasionally it has more than three spiral ridges, a feature which it shares with our shell. This is shown in my figure 22. Wood's fig. 1*b.* (*op. cit.*), which is very good, illustrates the usual tricarinate form of this variety. The variety *icenica* is smaller and the whorls are flattened, the base of the shell being subangular and not rounded as in the type. In the Red Crag, the type form is fairly common, and it is strong and solid; in the Norwich Crag, on the other hand, where the var. *icenica* is locally abundant, its appearance and texture are different, being thin and fragile, so that it is difficult to obtain a perfect specimen of it, indicating I think an alteration in the conditions under which this mollusc then lived.

A similar difference may be noticed in the case of some other species, as in *Cardium edule*, specimens of which in the Red Crag are large and strong with coarse sculpture, while those from the Icenian Crag, as at Bramerton, are, as a rule, small and fragile. A similarly small and fragile variety of *Buccinum undatum* is also found at the latter place, the large and strong form of the Red Crag being, so far as I know, absent.

An explanation of these facts may possibly be found in the writings of Scandinavian and other authors. Dr. Munthe states, for example, that in the Baltic at the present time the size and solidity of certain marine shells bear a fixed relation to the salinity of the water; moreover, that during the existence of what is known as the "Littorina Sea" when, owing to a subsidence of the land, the salinity was greater than it is now, such molluscs, of which he specially mentions *Cardium edule*, were larger and stronger than those living to-day in the same region.[2]

Sir Charles Lyell, moreover, dealing with the kitchen-middens of the Baltic, states that the mollusca found in them are of the usual oceanic type, whereas those now living in the same region only attain one third of their normal size, being

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[1] The shell described by Nyst in 1843 as *Cerithium tricinctum* (Coq. foss. Terr. Tert. Belg., p. 539, pl. xlii, fig. 7) was afterwards identified by him (*op. cit.*, 1881, p. 80) with the *C. Lamarckii* of Brongniart.

[2] Bull. Geol. Inst. Univ. Upsala, vol. ii, pp. 3 *et seq.*, 1894.

dwarfed in their growth by the quantity of fresh water poured by rivers into that inland sea;[1] Prof. Ed. Forbes also, describing a visit to a brackish lake in South Arran, remarks that he found in it an interesting variety of *Cardium edule*, the shells of which were remarkably thin and brittle.[2]

Such facts suggest that there may have been, during the later stages of the Crag period, a gradual diminution in the salinity of the Crag sea. This view would also explain the comparative and increasing poverty of the molluscan fauna of the Icenian deposits as compared with its great variety and abundance during those of the periods preceding.

It seems that during an early stage of the Red Crag history the sea was closed to the south and open to the north.[3] The advance of the great ice-sheet to which, in the opinion of most geologists, the distribution of Scandinavian erratics over northern Europe was due, may have gradually obstructed this northern communication and eventually have brought it to an end. Volumes of fresh water from the south, however, under such circumstances, especially during summer, would have brought into existence a lake, the water of which became increasingly brackish. Some such cause as this may have changed the character of the Pliocene molluscan fauna of the North Sea and finally have exterminated a great part of it. Although communication with the ocean was subsequently re-established by the cutting of the Straits of Dover, at first perhaps an overflow channel to the Icenian lake, the molluscan fauna of the East Anglian region has never regained the richness and variety it possessed during the earlier stages of the Pliocene epoch.[4]

Genus **BITTIUM** (Leach), Gray, 1847.

Bittium reticulatum (Da Costa). Plate XLI, figs. 1—3.

1778. *Strombiformis reticulatus*, Da Costa, Brit. Conch., p. 117, pl. viii, fig. 13.
1833. *Cerithium reticulatum*, S. Woodward, Geol. Norfolk, p. 36, pl. i, fig. 2.
1853. *Cerithium reticulatum*, Forbes and Hanley, Brit. Moll., vol. iii, p. 192, pl. xci, figs. 1, 2.
1863–69. *Cerithium reticulatum*, Jeffreys, Rep. Brit. Assoc. (Newcastle-on-Tyne), p. 77, 1863; Brit. Conch., vol. iv, p. 258, 1867; vol. v, p. 217, pl. lxxx, fig. 4, 1869.
1870–1915. *Cerithium reticulatum*, A. Bell, Journ. de Conch., vol. xviii, p. 350; Ann. Mag. Nat. Hist. [4], vol. vi, p. 215, 1915.
1872. *Cerithium reticulatum*, S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. i, p. 50, pl. v, fig. 22.

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[1] Antiquity of Man, 3rd ed., p. 13.

[2] Nat. Hist. Brit. Seas, p. 230, 1859.

[3] See Quart. Journ. Geol. Soc., vol. lii, p. 754, 1896.

[4] It should be stated, however, that the observations of Prof. Bateson on the variations of *C. edule* in certain lake-basins in Central Asia which seem to have been coincident with changes in their salinity (Phil. Trans. Roy. Soc. London, vol. clxxx, p. 316) do not correspond with those of Dr. Munthe. In any case, however, the influence of salinity on the growth of mollusca must have been indirect, probably in affecting the supply of suitable food.

1873–5. *Cerithiolum reticulatum*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 348, no. 220, 1873; vol. vi, p. 344, no. 420, 1875.
1884. *Bittium reticulatum* and vars, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 212, pl. xxv, figs. 1—27.
1886. *Bittium reticulatum*, Dollfus et Dautzenberg, Feuilles des jeunes Nat., vol. xvi, p. 105.
1890. *Bittium reticulatum*, Carus, Prod. Faun. Medit., vol. ii, p. 360.
1892. *Bittium reticulatum*, Locard, Coq. mar. Côtes de France, p. 120, fig. 108.
1895. *Bittium reticulatum* and vars., Sacco, Moll. Terr. Terz. Piem., pt. xvii, p. 38, pl. ii, figs. 105—14.
1898. *Cerithium reticulatum*, A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 143.
1901. *Bittium reticulatum*, Brøgger, Norges geol. Undersøgelse, no. 31, p. 661, pl. ix, fig. 8.
1901–7. *Bittium reticulatum*, Scalia, Atti Accad. Gioen. Sci. Nat. Catania, vol. xiv, p. 13, no. 151, 1901; vol. xx, p. 34, no. 227, 1907.
1908. *Bittium reticulatum*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iv, p. 101, pl. cxviii, figs. 1—10.
1910. *Bittium reticulatum*, Øyen, Kongl. Norske. Vid. Selsk. Skrift., no. 9, pp. 16, 31, 34.
1912. *Bittium reticulatum*, Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 143, pl. xxiii, figs. 12—22.

Specific Characters.—Shell small, slender, forming an elongated pyramid with a narrow base and an acute apex, rather solid; whorls 15—16, in the British variety, both recent and fossil, but slightly convex, regularly tapering, the last about one-third the total length; ornamented by 3—4 thread-like spiral ridges, crossed by numerous longitudinal ribs which become granulate at the points of contact and are sometimes varicose but do not extend below the periphery; suture well-marked but not deep: mouth ovate, angulated above, rounded below; basal groove shallow, rather wide, turning to the left; columella short and flexuous.

Dimensions.—L. 12 mm. B. 4 mm.

Distribution.—*Recent:* common on the western and southern coasts of Great Britain and Ireland, abroad from the Lofoten islands to the Canaries. Mediterranean, Adriatic and Ægean.

Fossil; St. Erth. Newbournian Crag: Ramsholt. Icenian: Norwich, Aldeby.

Pleistocene: Kelsey Hill, Nar Valley, Selsey (A. Bell), Torbay, Bridgewater. Scotland, *passim.* Ireland, Dublin, estuarine clays of Belfast (very common).

Holocene: Portrush.

Miocene: France, Italy, Vienna basin.

Lower Pliocene: Biot, Piedmont, Ligurian coast, Siena.

Upper Pliocene: northern Italy, Monte Mario, Altavilla.

Pleistocene: Livorno, Taranto, Reggio, Messina, Monte Pellegrino, Ficarazzi, Catira, Nizzeti. Denmark. Uddevalla. *Tapes*-banks: Christiania, Trondhjem. Eemien: Holland.

Remarks.—The present species, formerly known as *Cerithium reticulatum*, has been taken of late years as typical of the genus *Bittium*, a distinct group of small Cerithiidæ, which are elongate, turreted and many-whorled, with granulated sculpture, a very short canal and a rounded base.

Prof. Sacco states that this form is abundant in the Upper and Lower Pliocene of northern Italy. Sign. Cerulli-Irelli reports it from Monte Mario, A. Bell from Biot, Seguenza from Altavilla, and from a number of Pleistocene localities in Sicily and southern Italy, and Dr. Scalia from the sub-Etnaen deposits of Catira and Nizzeti. It is common as a recent shell on the southern and western coasts of Great Britain, ranging from the Lofoten Isles to the Canaries and to the Ægean, occurring also in many Pleistocene deposits in this country, as well as in those of Scandinavia. It is rare, however, in the English Crag and has not been reported from that of Belgium or Holland.

The specimen figured by Wood was from the Nar brick-earth (late Pleistocene); one of those here given (fig. 2), which shows the varicose ribs characteristic of the present species, is from the Icenian Crag of Aldeby, the other from the Newbournian of Ramsholt.

Var. **trinodosa** (Etheridge and A. Bell). Plate XLI, fig. 4.

1885. *Cerithium reticulatum*, S. V. Wood, Quart. Journ. Geol. Soc., vol. xli, p. 70.
1886. *Cerithium reticulatum*, var , Kendall and R. G. Bell, Quart. Journ. Geol. Soc., vol. xlii, p 211.
1898. *Cerithium* (*Bittium*) *reticulatum*, var. *trinodosa* (*pseudoreticulatum*, S. V. Wood, MS.), A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 143, pl. i, fig. 13.

Varietal Characters.—Differs from the type in having three rows of nodules instead of four, a longer spire and a deeper suture; the base is encircled by two thin prominent ridges and there is usually a fine thread on the body-whorl between the two upper rows.

Dimensions.—L. 14 mm. B. 3 mm.

Distribution.—*Recent:* southern coast of England (A. Bell).
Fossil: St. Erth.

Remarks.—This is one of the most abundant forms of the St. Erth fauna, being found in all our collections from that place. Mr. A. Bell informs me that in a letter received from M. Dollfus the latter said "perhaps it is a new species." The former states he has seen two recent specimens, very much like the St. Erth fossils, which had been picked up on our southern coast.

Bittium lacteum (Philippi). Plate XLI, figs. 7, 8.

1836–44. *Cerithium lacteum*, Philippi, Enum. Moll. Sic., vol. i, p. 195, 1836; vol. ii, p. 162, 1844.
1868. *Cerithium elegans*, Weinkauff (non Blainville), Conch. Mittelm., vol. ii, p. 164.
1872. *Cerithiopsis lactea ?*, S. V. Wood, Mon. Crag Moll., 1st Suppl., p. 52, pl. iv, fig. 16.
1878–84. *Cerithiolum lacteum*, Monterosato, Enum. e Sinon. Conch. Medit., p. 38, 1878; Nom. Gen. e Spec. Conch. Medit., p. 122, 1884.

1884. *Bittium lacteum* and vars., Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 215, pl. xxvi, figs. 1—7.

1890. *Bittium lacteum,* Carus, Prod. Faun. Medit., vol. ii, p. 362.

1892. *Bittium lacteum,* Locard, Coq. mar. Côtes de France, p. 122.

1901–7. *Bittium lacteum.* Scalia, Atti Accad. Gioen. Sci. Nat. Catania [4 *a*], vol. xiv, p. 13, 1901; vol. xx, p. 34, 1907.

1906. *Bittium lacteum,* Cossmann, Ess. Paléoconch. compar., vol. vii, p. 137.

1908. *Bittium lacteum,* Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iv, p. 103, pl. cxviii, figs. 23, 24.

1917. *Inobittium lacteum,* Monterosato, Moll. viv. e quat. Tripoli, p. 20; Boll. Soc. Zool. Ital. [3], vol. iv.

Specific Characters.—Shell small, solid, turreted; spire acuminate, suture distinct; whorls 7 or 8, flattened, gradually diminishing in size upwards towards a blunt point; ornamented by three rows of strong, regularly spaced, but rather inconspicuous tubercles; base rounded, with non-tuberculate ridges; mouth small, ovate; columella oblique, twisted near the base; canal very short.

Dimensions.—L. 7 mm. B. 2·5 mm.

Distribution.—*Recent:* Scilly Isles (Marshall). Mediterranean, Adriatic, north Atlantic as far south as Madeira. Tripoli.

Fossil: Coralline Crag: Sutton? Waltonian: Little Oakley.

Post-Pliocene: Catania district.

Remarks.—Except for a single specimen from the Coralline Crag of Sutton reported by Wood with some doubt, the present Mediterranean and southern species has not been recognized hitherto from the Crag; I have found several specimens, some of them imperfect, which appear to correspond with a recent shell received from my friend M. Dautzenberg. Seguenza reports *Cerithiolum lacteum* from the Upper Pleistocene of Sicily, identifying it with the *C. elegans* of Blainville, but MM. Bucquoy and his colleagues, with Prof. Kobelt, in the works referred to above, state that, in their opinion, it is the *C. elegans* of Weinkauff rather than that of Blainville which truly represents the *C. lacteum* of Philippi. The prolific pit at Little Oakley is the second Crag locality from which this species has been recognized as a fossil.

Dr. Scalia reports it from the sub-Etnaen deposits of Nizzeti, Catira, and elsewhere.

Bittium robustum, sp. nov. Plate XLI, figs. 9, 10.

Specific Characters.—Shell turreted, strong and solid; whorls 7 or 8, but slightly convex; spire regularly diminishing in size to a blunt point; ornamented by about 12 strong and oblique costæ, equal to the spaces between them, and by 3 or 4 well-marked spiral ridges which become coarsely tuberculate at the

points of contact; suture distinct but not deep; mouth oval, angulate above; base rounded.

Dimensions.—L. 10 mm. B. 3 mm.

Distribution.—Not known living.

Fossil: Waltonian Crag: Little Oakley.

Scaldisien: Antwerp.

Remarks.—I have half a dozen specimens from Oakley of what seems to me a distinct form. It is a strong shell, with coarse sculpture. When examining M. van de Wouwer's collection at Antwerp I noticed some examples from the Scaldisien of what was evidently the same species. He was kind enough to give me a specimen which I have here figured under the above name, together with one of my Oakley fossils.

Bittium punctulum (S. V. Wood). Plate XLI, figs. 5, 6.

1842–79. *Cerithium punctulum*, S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix, p. 538. 1842; *C. variculosum* (non Nyst), Mon. Crag Moll., pt. i, p. 69, pl. viii, fig. 3, 1848; 2nd Suppl., p. 23, pl. ii, fig. 15, 1879.

1871. *Cerithium reticulatum*, var., Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 487.

1872. *Cerithium variculosum*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 209.

1874. *Cerithium variculosum*, Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, p. 285.

1881. *Cerithium punctulum*, Nyst, Conch. Terr. Tert. Belg., p. 77, pl. vi, fig. 8.

1898. *Cerithium reticulatum*, var. *punctulum* (*C. variculosum* in plate), A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 144, pl. i, fig. 12.

1912. *Cerithium punctulum*, Tesch, Med. v. d. Rijks. v. Delfstoffen, no. iv, p. 76, no. 180.

Specific Characters.—Shell small, slender, elongate, turreted; whorls 10, slightly convex, the last one-third the total length; delicately ornamented by a number of well-marked, closely-set longitudinal costæ and by 4 spiral ridges which are tuberculate at the points of contact; spire attenuate, regularly diminishing in size to a rather blunt point; base rounded with 2 non-tuberculate ridges; suture fairly deep; mouth ovate, angulate above; outer lip thin; canal very short.

Dimensions.—L. 9 mm. B. 3 mm.

Distribution.—Not known living.

Fossil: St. Erth. Waltonian Crag: Walton-on-Naze, Little Oakley. Newbournian: Ramsholt.

Scaldisien: Antwerp (Nyst), Dutch borings (Tesch).

Remarks.—Some confusion still exists as to the correct nomenclature of this species, Wood's type specimen in the British Museum being labelled *Cerithium variculosum.* This by the kindness of Dr. A. Smith Woodward I am able to figure; the original drawing does not satisfactorily represent it.

Originally given by Wood in his Catalogue of 1842 as *C. punctulum*, it was

afterwards referred by him to an Oligocene and different fossil described by Nyst in 1843 as *C. variculosum*,[1] an identification which seems to me improbable, as our specimens have no appearance of being derivative but appear to be genuine Crag shells.

The fact, however, that in 1881 Nyst figured a Scaldisien fossil as *C. punctulum* (*op. cit.*), identifying it with Wood's *C. punctulum* of 1842 and with his *C. variculosum* of 1848, but not with his own Oligocene *C. variculosum* of 1843, seems conclusive, showing he considered the two last named to be different. Our Crag species therefore should revert to its original name of *punctulum*, *variculosum* being confined to Nyst's Oligocene shell.

There are several specimens of this species in the British Museum from Walton, and I have found two or three, imperfect, at Oakley. There is another from Ramsholt, somewhat worn, in the York Museum under the name of *Cerithium variculosum* which may probably be the same.

The shell from the Norwich Crag figured by S. Woodward in 1833 as *C. punctatum*[2] is different, probably the variety *icenica* of *Potamides tricinctus*, Brocchi, which, as stated above, is abundant at that horizon.

Jeffreys referred the present form to *B. reticulatum* (*op. cit.*), a view which I am unable to accept.

Genus **CERITHIOPSIS**, Forbes and Hanley, 1849.

Cerithiopsis Barleei, Jeffreys. Plate XLI, figs. 14, 15.

1848–74. *Cerithium tuberculare,* var. *subulata,* S. V. Wood, Mon. Crag Moll., pt. i., p. 10, pl. viii, fig. 5 *b*, 1848; *Cerithiopsis tubercularis,* 1st Suppl., pt. ii, p. 181, 1874.

1867–85. *Cerithiopsis Barleei,* Jeffreys, Brit. Conch., vol. iv, p. 268, 1867; vol. v, p. 217, pl. lxxxi fig. 2, 1869; Proc. Zool. Soc. Lond., p. 60, 1885.

1873. *Cerithiopsis Barleei,* Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 350, no. 226.

1892. *Cerithiopsis Barleei,* Locard, Coq. mar. Côtes de France, p. 117.

1906. *Cerithiopsis tubercularis,* var. *Barleei,* Cossmann, Ess. Paléoconch. compar., vol. vii, p. 146.

1908. *Cerithiopsis barleei,* Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iv, p. 117, pl. cxx, fig. 8.

Specific Characters.—Shell minute, slender, forming an elongated pyramid, with a broadish and excavated base; whorls 12, compressed, slightly convex, the last one-third the total length; spire regularly tapering; ornamented by longitudinal costæ and by spiral lines, tuberculate at the points of contact, having no basal ridge; mouth irregularly rhomboid, truncated; pillar very short, slightly curved; canal semi-tubular, with a deep and obliquely rounded notch at the base.

Dimensions.—L. 6 mm. B. 2 mm.

[1] Coq. foss. Terr. Tert. Belg., p. 540, pl. xlii, fig. 9.

[2] Geol. of Norfolk, p. 44, pl. iii, fig. 29.

Distribution.—Recent: English Channel, south-west coast of Ireland. Mediterranean, West European.

Fossil: Coralline Crag: Sutton (A. Bell). Waltonian: Little Oakley.

Pleistocene: Ficarazzi.

Remarks.—The shell figured under the present name which I obtained at Oakley, has been identified as *C. Barleei* by M. Dautzenberg, who has kindly sent me a recent specimen for comparison. Wood considered this form to be a variety of *C. tubercularis* as does M. Cossmann, but it has been more generally regarded as specifically distinct. Jeffreys says it is not unlike *C. metula* but is more strongly tuberculate and has a true canal, and that it may be distinguished from *C. tubercularis* by its wider base, having no basal keel, some of its upper whorls being finely striated in the line of the spire. It seems to be a rare southern form, ranging from the Mediterranean to the English Channel and the western coasts of Ireland. Wood reports it from the Coralline Crag of Sutton and I have found it, as just stated, at Oakley. Except that Seguenza gives it from one locality of the Sicilian Pleistocene it has not been recognised as a fossil, except in the English Crag. Jeffreys states it was taken during the Porcupine Expedition at Station 9.

Cerithiopsis tubercularis (Montagu). Plate XLI, figs. 20—21.

1803–8. *Murex tubercularis*, Montagu, Test. Brit., pt. 1, p. 270, 1803; Suppl., p. 116, 1808.

1848–72. *Cerithium tuberculare*, S. V. Wood, Mon. Crag Moll., pt. i, p. 70, pl. viii, fig. 5, 1848; *Cerithiopsis tubercularis*, 1st Suppl., pt. i, p. 52, 1872.

1853. *Cerithiopsis tubercularis*, Forbes and Hanley, Brit. Moll., vol. iii, p. 365, pl. xci, figs. 7, 8.

1867–71. *Cerithiopsis tubercularis*, Jeffreys, Brit. Conch., vol. iv, p. 266, 1867; vol. v, p. 217, p. lxxxi, fig. 1, 1869; in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, pp. 143, 487, 1871.

1872. *Cerithiopsis tubercularis*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 203, 213.

1873–5. *Cerithiopsis tubercularis*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 350, no. 225, 1873; vol. vi, p. 344, no. 425, 1875.

1874. *Cerithium tuberculare*, Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, p. 356.

1878. *Cerithiopsis tuberculare*, de Stefani e Pantanelli, Bull. Soc. Malac. Ital., vol. iv, p. 160.

1880. *Cerithiopsis tubercularis*, Fontannes, Moll. plioc. Vallée du Rhone, vol. i, p. 167, pl. ix, fig. 14.

1880. *Cerithiopsis tubercularis*, Dollfus, Esq.Terr.tert.Normandie, p. 40.

1884. *Cerithiopsis tubercularis*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 204, pl. xxvii, figs. 1—4.

1886. *Cerithiopsis tubercularis*, Dollfus et Dautzenberg, Feuilles des jeunes Nat., vol. xvi, p. 105.

1890. *Cerithiopsis tubercularis*, Carus, Prod. Faun. Medit., vol. ii, p. 363.

1892. *Cerithiopsis tubercularis*, Locard, Coq. mar. Côtes de France, p. 117, fig. 105.

1895. *Cerithiopsis tubercularis* and vars., Sacco, Moll. Terr. Tert. Piem., pt. xvii, p. 66, pl. iii, figs. 72, 73, 74.

1901. *Cerithiopsis tubercularis*, Brøgger, Norges geol. Undersøgelse, no. 31, pp. 561, 661, pl. xix, fig. 2.

1906. *Cerithiopsis tubercularis*, Cossmann, Ess. Paléoconch. compar,, vol. vii, p. 145.

1908. *Cerithiopsis tubercularis*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iv, p. 116, pl. cxx, figs. 1, 2, 3, 6, 7.

1912. *Cerithium tuberculare*, Tesch, Med. v. d. Rijks. v. Delfstoffen, no. iv, p. 76, no. 181.

Specific Characters.—Shell minute, solid, sub-cylindrical; whorls 13—14, compressed, the last one-third the total length; spire slender, turreted, elongate, becoming suddenly smaller near the apex; embryonic whorls smooth, the others ornamented by 3 rows of closely-set tubercles; suture channelled, not deep; base angulate, slightly excavated, having two non-tuberculate ridges, one just below the periphery; mouth sub-quadrangular; canal short, sub-cylindrical, notched.

Dimensions.—L. 6 mm. B. 2 mm.

Distribution.—Recent: coasts of Great Britain and Ireland from the Channel Islands to the Shetlands and Orkneys. Mediterranean, Adriatic, Tripoli. North Atlantic from Christiansund to Madeira.

Fossil: Coralline Crag: Gedgrave, Sutton, Boyton. Waltonian: Walton-on-Naze. Newbournian: Waldringfield, Newbourn, Sutton. Butleyan: Shottisham, Hollesley. Icenian: Bramerton.

Casterlien (zone *à Isocardia cor*): Belgium, Dutch borings.

Pleistocene: Clyde basin.

Holocene: Portrush.

Miocene: France—Touraine; Italy (Elveziano, Tortoniano).

Pliocene: Piedmont, Siena, Parma, Messina, Altavilla. Normandy, Rhone Valley, Biot.

Pleistocene: Livorno, Valle Biaia, Messina, Ficarazzi, Monte Pellegrino, *Tapes*-banks of Christiania.

Remarks.—This species was obtained by Wood somewhat abundantly from the Coralline Crag, but it is less common in the Red and Icenian deposits. Prof. Brøgger includes it in his list of Lusitanian species from the *Tapes*-banks of Christiania, and it has been found fossil in the Pleistocene deposits of the Clyde basin as well as in the Holocene of Portrush in the north-east of Ireland, and recent at Christiansund. As it is prevalently a southern shell, its occurrence so far north may be a survival from the post-glacial times when milder conditions obtained in those latitudes.

According to Italian authorities, *C. tubercularis* was in existence in the Mediterranean region in the Miocene epoch. It had a wide Continental range during the Pliocene, and occurs also in the post-Pliocene beds of Calabria and Sicily. Prof. Sacco suggests it may have been derived from the Oligocene *Cerithium Henckeliusii* of Nyst, with which it has been sometimes identified.

M. Van den Broeck records it from the zone *à Isocardia cor* of Zwyndrecht near Antwerp, and Dr. Tesch from beds of similar age met with in the Dutch borings.

Cerithiopsis Metaxæ (Delle Chiaje). Plate XLI, figs. 16—19.

1829. *Murex Metaxæ,* Delle Chiaje, Mémoire, vol. iii, p. 222, pl. xlix, figs. 29, 30.
1848. *Cerithium metaxa,* S. V. Wood, Mon. Crag Moll., pt. i, p. 71, pl. viii, fig. 6.
1863. *Cerithium Crosseanum,* Tiberi, Journ. de Conch., vol. xi, p. 158, pl. vi, fig. 2.
1867–85. *Cerithiopsis Metaxa,* Jeffreys, Brit. Conch., vol. iv, p. 271, 1867; vol. v, p. 217, pl. lxxxi, fig. 4, 1869; in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, pp. 142, 487, 1871; Proc. Zool. Soc., p. 61, 1885.
1870. *Cerithiopsis metaxa,* A. Bell, Journ. de Conch., vol. xviii, p. 350.
1872. *Cerithiopsis metaxa,* A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 203, 209.
1873. *Cerithiopsis metaxa,* Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 350, no. 228.
1884. *Cerithiopsis Metaxæ,* Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 207, pl. xxvi, figs. 21—27.
1890. *Cerithiopsis Metaxæ,* Carus, Prod. Faun. Medit., vol. ii, p. 366.
1892. *Cerithiopsis Metaxæ,* Locard, Coq. mar. Côtes de France, p. 117.
1908. *Cerithiopsis metaxa,* Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iv, p. 119, pl. cxviii, fig. 18; pl. cxx, figs. 9, 10.
1917. *Metaxia Metaxa,* Monterosato, Moll. viv. e quat. Tripoli, p. 20; Boll. Soc. Zool. Ital. [3], vol. iv.

Specific Characters.—Shell small, solid, subcylindrical, turreted; whorls 14—15, convex, the last about one-third the total length, more or less excavated below; spire slender, elongate; ornamented by longitudinal and by four spiral ridges, finely granulate where they intersect; base smooth, flattened and angulated by a non-tuberculate ridge; suture wide and deep; mouth sub-circular; canal short, rather wide and open, notched; outer lip scalloped within by the spiral ridges; pillar short, flexuous.

Dimensions.—L. 6—8 mm. B. 1·5—2 mm.

Distribution.—*Recent:* British seas, Guernsey, Cornish coast, Shetland. Vigo bay, Gibraltar. Mediterranean, Adriatic, Tripoli.

Fossil: Coralline Crag: Sutton, Gomer. Waltonian: Walton-on-Naze, Little Oakley. Newbournian: Waldringfield.

Pleistocene: Selsey (A. Bell). Messina, Monte Pellegrino, Ficarazzi, Valle Biaia.

Remarks.—Judging from the specimens represented by the authorities quoted above and by those that have fallen into my hands, *C. Metaxæ* seems to be a variable species, both as to form and sculpture. Wood's figure 5 *b* is not unlike those given by the authors of the *Moll. marins du Roussillon,* but very different from those of Jeffreys or Prof. Kobelt. Seguenza includes *C. Metaxæ* in his list of Pleistocene shells from Italy and Sicily, but I cannot find it has been recorded from any earlier horizon on the Continent. It has been reported by Jeffreys and the brothers Bell from the Coralline and Red Crags and by Mr. A. Bell from Selsey, as well as from Walton-on-Naze and Waldringfield. I have obtained it also at Oakley. I have figured some typical recent shells received from my friend

M. Dautzenberg for the guidance of future collectors. One of the fossils here given (fig. 19) is considerably larger than the type but he informs me that such specimens are occasionally met with. *C. Metaxæ* is a distinctly southern form; so far as this country is concerned it is rare, both as a fossil and living.

Cerithiopsis minima (Brusina). Plate XLI, figs. 22, 23.

1848. *Cerithium tuberculare*, var. *nanum*, S. V. Wood, Mon. Crag Moll., pt. i, p. 70, pl. viii, fig. 5 *c*.

1865–6. *Cerithium minimum*, Brusina, Conch. Dalm. ined., p. 17, 1865; *Cerithiopsis minima*, Contr. Faun. Dalmat., p. 71, 1866.

1868. *Cerithiopsis minima*, Weinkauff, Conch. Mittelm., vol. ii, p. 170.

1875–8. *Cerithiopsis tubercularis*, var. *minima*, Monterosato, Nuov. Rivist., p. 38, 1875; *C. minima*, Enum. e Sinon. Conch. Medit., p. 39, 1878.

1884. *Cerithiopsis minima*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 207, pl. xxvii, figs. 5—9.

1886. *Cerithiopsis minima*, Dollfus et Dautzenberg, Feuilles des jeunes Nat., vol. xvi, p. 105.

1890. *Cerithiopsis minima*, Carus, Prod. Faun. Medit., vol. ii, p. 364.

1892. *Cerithiopsis minima*, Locard, Coq. mar. Côtes de France, p. 119, fig. 106.

1895. *Cerithiopsis tubercularis*, var. *nana*, Sacco, Moll. Terr. Terz. Piem., pt. xvii, p. 66.

1908. *Cerithiopsis minima*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iv, p. 124, pl. cxx, figs. 16, 17.

1912. *Cerithiopsis minima*, var. *ovoides*, Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 148, pl. xxiii, fig. 47.

1917. *Cerithiopsis minima*, Monterosato, Moll. viv. e quat. Tripoli, p. 20; Boll. Soc. Zool. Ital. [3], vol. iv.

Specific Characters.—Shell minute, solid, turriculate, conical at the summit, slightly swelled in the middle, contracted at the base; whorls nearly flat, ornamented by three rows of rounded tubercles; suture very slight; mouth quadrangular; canal very short; columella flexuous.

Dimensions.—L. 3 mm. B. 1 mm.

Distribution.—*Recent:* Great Britain—English Channel, Killala Bay, western Hebrides. Mediterranean—Pauilles, Algiers, Tunis, Sicily, Tripoli. Adriatic—Dalmatia. Atlantic coasts as far south as Madeira.

Fossil: Coralline Crag: Sutton.

Miocene: Touraine.

Upper Pliocene: Monte Mario.

Remarks.—The minute fossils here figured are from the Wood collection at the Norwich Museum, having been obtained from the bed of small shells at Sutton which has yielded so many interesting specimens. Two varieties of this species have been described by the authors above mentioned, one a minute, short and pupoid form agreeing very nearly with my fig. 23 and with that from Monte Mario figured by Sign. Cerulli-Irelli as *C. minima*, var. *ovoides* (*op. cit.*, fig. 47), the other (fig. 22) longer in the spire.

The Marchese di Monterosato originally regarded *C. minima* as a variety of *C. tubercularis*, but in a subsequent work reverted to Brusina's opinion that it was specifically distinct.

Mr. Marshall considers that the var. *nana* of Wood is the *C. concatenata* of Conti, stating that under the latter name it has been taken in the western part of the English Channel as far as the Scilly Islands, in Killala Bay, and in the western Hebrides.[1] The variety *nana* of Jeffreys seems to be a different shell.

Genus **NEWTONIELLA**, Cossmann, 1893.

Sub-genus **SEILA**, H. and A. Adams, 1861.

Newtoniella (Seila) trilineata (Philippi). Plate XLI, fig. 24.

1836–44. *Cerithium trilineatum*, Philippi, Enum. Moll. Sic., vol. i. p. 195, pl. xi, fig. 13, 1836; vol. ii, p. 163, 1844.

1842–48. *Cerithium trilineatum*, S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix, p. 537, 1842; Mon. Crag Moll., pt. i, p. 70, pl. viii, fig. 4, 1848.

1856. *Cerithium trilineatum*, Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 413, pl. xlii, fig. 19.

1867. *Cerithium trilineatum*, Speyer, Palæontographica, vol. xvi, p. 211, pl. xxiii, fig. 9; pl. xxiv, fig. 1.

1871. *Cerithium trilineatum*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, pp. 143, 487.

1872. *Cerithium trilineatum*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 203, 210.

1873. *Cerithium trilineatum*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 348, no. 217.

1874. *Cerithium trilineatum*, Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, p. 134.

1886. *Cinctella trilineata*, Dollfus et Dautzenberg, Feuilles des jeunes Nat., vol. xvi, p. 105.

1890. *Cerithium* (*Cinctella*) *trilineatum*, Carus, Prod. Faun. Medit., vol. ii, p. 360.

1890–5. *Cerithium trilineatum ?*, Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 188, no. 2085, 1890; *Cerithiella* (*Seila*) *trilineata* and vars., Moll. Terr. Tert. Piem., pt. xvii, p. 72, pl. iii, figs. 94, 95, 1895.

1892. *Cerithiopsis trilineata*, Locard, Coq. mar. Côtes de France, p. 118.

1898. *Cerithiopsis* (*Cinctella*) *trilineata*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. ii, p. 796.

1906. *Newtoniella* (*Seila*) *trilineata*, Cossmann, Ess. Paléoconch. compar., vol. vii, p. 153.

1917. *Seila trilineata*, Monterosato, Moll. viv. e quat. Tripoli; Boll. Soc. Zool. Ital. [3], vol. iv.

Specific Characters.—Shell small, subcylindrical, subulate; apex obtuse, costated and cancellate; whorls flattened; ornamented by three obtuse spiral ridges and by numerous exceedingly fine spiral striæ; suture slight; mouth subquadrangular; canal short and inflected, base rounded.

Dimensions.—L. 9 mm. B. 2 mm.

Distribution.—*Recent:* Mediterranean, Ægean, Tripoli.

Fossil: Coralline Crag: Gedgrave, Sutton, Boyton. Waltonian: Walton-on-Naze, Little Oakley.

[1] Journ. of Conch., vol. xiii, p. 186, 1912.

Miocene: Vienna basin, Touraine, Belgium, northern Italy.

Pliocene—Upper and Lower: Italy.

Pleistocene: Livorno.

Remarks.—This species, generally a rare form, is recorded as recent from southern seas only, and abroad as fossil from the Miocene to the Pleistocene. As a Crag shell it occurs in the Coralline Crag and very occasionally in the Waltonian. It seems to have been one of the Miocene species which were dying out in the Anglo-Belgian basin at the commencement of the Red Crag period. I have no note of it from any English horizon later than that of Oakley.

The list of references here given will show that our best authorities are by no means agreed as to the more correct generic and sub-generic names of this little shell. Those I have adopted must be regarded, therefore, as provisional.

Genus **TRIFORIS**, Deshayes, 1824.

Triforis perversa (Linné), var. **adversa** (Montagu). Plate XLI, fig. 25.

1758. *Trochus perversus*, Linné, Syst. Nat., ed. x, p. 760, no. 523.

1803. *Murex adversus*, Montagu, Test. Brit., vol. i, p. 271.

1848–74. *Cerithium adversum*, S. V. Wood, Mon. Crag Moll., pt. i, p. 72, pl. viii, fig. 8, 1848; *C. perversum*, var. *Belli*, 1st Suppl., pt. ii, p. 181, add. pl., fig. 17, 1874.

1853. *Cerithium adversum*, Forbes and Hanley, Brit. Moll., vol. iii., p. 195, pl. xci, figs. 5, 6.

1856. *Cerithium perversum*, Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 414, pl. xlii, fig. 20.

1867–71. *Cerithium perversum*, Jeffreys, Brit. Conch., vol. iv, p. 261, 1867; vol. v, p. 217, pl. lxxx, fig. 5, 1869; *Triforis perversa*, in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, pp. 142, 487, 1871.

1870–98. *Triforis adversa*, A. Bell, Ann. Mag. Nat. Hist. [4], vol. vi, p. 215, 1870; Journ. de Conch., vol. xviii, p. 350, 1870; Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 144, 1898.

1872. *Triforis perversa*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 204, 210.

1873–5. *Triforis perversa*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 356, no. 224, 1873; vol. v, p. 280, no. 88, 1874; vol. vi, p. 344, no. 424, 1875.

1874–92. *Cerithium perversum*, Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, p. 292, 1874; *Triforis* (*Cerithium*) *perversus*, Bull. Soc. Belge Géol., vol. vi (Mémoires), pp. 123, 147, 1892.

1881. *Cerithium perversum*, Nyst, Conch. Terr. Tert. Belg., p. 76, pl. vi, fig. 7.

1884. *Triforus perversus* and var. *adversa*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 209, pl. xxvi, figs. 8–11, 14–17.

1890–5. *Triforis perversa* and vars., Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 190, no. 2128; p. 326, no. 5373, 1890; *T.* (*Monophorus*) *perversus*, var. *adversa*, Moll. Terr. Tert. Piem., pt. xvii, p. 63, pl. iii, fig. 62, 1895.

1901. *Triforis perversa*, Brøgger, Norges geol. Undersøgelse, no. 31, p. 661, pl. xviii, fig. 13.

1908. *Triforis* (*Biforina*) *perversus*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iv, p. 131, pl. cxxi, figs. 1, 2.

1912. *Triphora perversa*, Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 151, pl. xxiii, figs. 53–60.

Specific Characters.—Shell small, sinistral, sub-cylindrical; whorls about 15, compressed, the last about one-third the total length; spire elongate, tapering to a fine point; ornamented by longitudinal and spiral ridges which produce closely-set

and strong tuberculation where they intersect, but are never varicose; there are three spiral rows on the lower whorls, the centre row becoming smaller and squeezed out on the upper ones, the base of the shell being rounded and spirally ridged; suture slight, narrowly channelled; mouth sub-quadrangular; labial groove narrow, turning to the right; inner lip broad, forming a thick pad on the pillar.

Dimensions.—L. 8—12 mm. B. 2—3 mm.

Distribution.—Recent: southern and western coasts of England and Wales, Ireland, Scotland from the Clyde to the Shetland Isles, Norwegian coast, Brittany to Madeira and the Canaries; generally diffused in the Mediterranean, Adriatic and Ægean; Morea, Egypt; west coast of N. America (Jeffreys).

Fossil: St. Erth. Gedgravian Crag: Gedgrave, Sutton. Waltonian: Walton-on-Naze, Little Oakley.

Pleistocene: Garvel Park, Cumbrae, Largo, Shewalton.

Holocene: Portrush.

Oligocene: Denmark, northern Germany?

Miocene: Italy (Elveziano, Tortoniano). Vienna basin. South-west France.

Lower Pliocene: northern Italy—many localities. Normandy, Biot.

Upper Pliocene: Asti, Bologna, Orciano, Legoli, Monte Mario. Sicily—Altavilla, Messina. Belgium—Scaldisien: Antwerp.

Pleistocene: Italy—Reggio, Taranto, Livorno, Valle Biaia. Sicily—Messina, Monte Pellegrino. Christiania fiord, *Tapes*-banks.

Remarks.—There are two forms of the present shell, originally regarded as specifically distinct, but now generally held to be varieties of our species. The one, *T. perversus*, Linné, is much the larger, sometimes exceeding 30 mm. in length. This is figured under that name as recent by MM. Bucquoy and his colleagues (*op. cit.*), and as fossil by Prof. Sacco and Sign. Cerulli-Irelli (*op. cit.*). It is typically southern, and does not occur, so far as I know, either living in British seas or in the Anglo-Belgian Pliocene. The other, *T. adversa*, is much smaller, from 8 mm. long, has a northern range, and is that found recent on the coasts of Great Britain, and fossil in the Crag and in the Pleistocene *Tapes*-banks of Norway. It is figured, however, as recent in the Mediterranean, and fossil in the Upper Pliocene of Italy, but under the name of *T. perversa* var. *adversa*, which I think correctly describes it.[1] Jeffreys says, "I can see no other difference than that of size between Mediterranean and British specimens."

Our shell was only known as a fossil to Wood from the Coralline Crag, but has been found since by Prof. Kendall at Walton, by myself at Oakley, by M. Dollfus in Normandy, and by Mr. Bell at St. Erth.

A nearly allied species from the Oligocene of north Germany and Denmark is described by Prof. von Koenen and others under the name of *Triforis Fritschi.*

[1] The Conchological Society of Great Britain has adopted the name *T. perversa* for the small British variety.

Genus **LÆOCOCHLIS,** Dunker and Metzler, 1874.

Læocochlis granosa (S. V. Wood). Plate XLI, figs. 11—13.

1842–8. *Cerithium granosum,* S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix, p. 538, 1842; Mon. Crag Moll., pt. i, p. 73, pl. viii, fig. 9, 1848.
1871. *Cerithium granosum,* Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, pp. 142, 487.
1872. *Cerithium granosum,* A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 203, 209, 213.
1874–84. *Cerithium sinistratum,* Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, pp. 134, 292; *C. granosum,* p. 351, 1874; vol. xix, p. 26, 1884.
1881. *Cerithium sinistratum,* Nyst, Conch. Terr. Tert. Belg., p. 78, pl. vi, fig. 9.
1899. *Læocochlis granosa,* Norman, Ann. Mag. Nat. Hist. [7], vol. iv, p. 152.
1906. *Læocochlis granosa,* Cossmann, Ess. Paléoconch. compar., vol. vii, p. 155.

Specific Characters.—Shell sinistral, turreted, elongate; whorls 10 or 12, somewhat convex, the last about one-third the total length, excavated below; suture well-marked, oblique; spire gradually diminishing in size towards a blunt apex; ornamented (in the Crag variety) by longitudinal and transverse ridges of equal value, giving the shell a regularly reticulated appearance, tuberculate at the points of intersection; in a recent and allied form (var. *Macandrewæ* of Dautzenberg and Fischer) the longitudinal ribs are generally obsolete or nearly so, being, when present, very fine and inconspicuous and confined to the upper whorls; base without sculpture; mouth oval; canal short, twisted, turning to the right.

Dimensions.—L. 15—30 mm. B. 4—8 mm.

Distribution.—(Of Crag form) Not known living.

Fossil: Coralline Crag: Gedgrave, Sutton. Waltonian: Walton-on-Naze, Beaumont, Little Oakley. Newbournian: Bentley, Newbourn, Waldringfield. Butleyan: Butley.

Casterlien, Scaldisien, Poederlien: Belgium.

Remarks.—In 1848 the present species was only known as a Crag fossil from one or two localities, but it has been recorded since then from all our East Anglian Pliocene horizons, from the Gedgravian to the Butleyan. I have obtained, for example, nearly forty specimens, most of them broken, at Oakley. The Belgian fossil from the Scaldisien of Antwerp, described by Nyst in 1881 as *C. sinistratum,* is probably the same, though Jeffreys at first thought it different, but as he afterwards identified some specimens in the Brussels Museum with our shell, a more probable explanation seems to be that Nyst's figure was more or less inaccurate. M. Van den Broeck's latest opinion was that the Belgian and English shells were identical.

The Crag species has been identified since 1878 by G. O. Sars, Jeffreys, and Friele with a recent and northern shell, *Triforis Macandrewæ,* H. and A. Adams, and with *Læocochlis Pommeraniæ,* Dunker and Metzler, the latter authorities having

proposed for this group of shells a new genus. Our Crag shell is now generally known as *Læocochlis granosa.*

MM. Dautzenberg and Fischer, recognising the difference as well as the similarity between the recent and the fossil form, have adopted for the former the name of *L. granosa*, var. *Macandrewæ.* Whether the separation should be specific or varietal is a matter for zoologists; in any case, Wood's specific name of *granosa* holds good for the Crag shell.

It may be pointed out, however, that the ascertained distribution of the two does not overlap, either in time or space. The fossil form seems to have disappeared from the Anglo-Belgian basin before the Icenian stage of the Pliocene period, and it has not been reported from our Pleistocene deposits. The recent shell has a distinctly northern range, crossing the Arctic circle and being unknown in British seas. The figure of it given by Prof. G. O. Sars ('Moll. Reg. arct. Norv.,' pl. xiii, fig. 6) is quite characteristic.

Genus **TRICHOTROPIS,** Broderip and Sowerby, 1829.

Trichotropis borealis, Broderip and Sowerby. Plate XLIV, figs. 36—38.

1829. *Trichotropis borealis,* Broderip and Sowerby, Zool. Journ., vol. iv, p. 395.
1841–70. *Trichotropis borealis,* Gould, Rep. Inv. Mass., ed. 1, p. 300, fig. 207, 1841; ed. 2, p. 390, fig. 651, 1870.
1842. *Trichotropis atlantica,* Möller, Ind. Moll. Groenl., p. 12.
1846. *Trichotropis borealis,* Lovén, K. Svensk. Vet.-Akad. Förh., vol. iii, p. 87.
1848. *Trichotropis borealis,* S. V. Wood, Mon. Crag Moll., pt. i, p. 67, pl. vii, fig. 17; pl. xix, fig. 11.
1853. *Trichotropis borealis,* Forbes and Hanley, Brit. Moll., vol. iii, p. 361, pl. ci, figs. 5, 6.
1867–71. *Trichotropis borealis,* Jeffreys, Brit. Conch., vol. iv, p. 245, 1867; vol. v, pl. lxxix, fig. 6, 1869; in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 145, 1871.
1872. *Trichotropis borealis,* Dawson, Canadian Nat. (n. s.), vol. vi, p. 395.
1873. *Trichotropis borealis,* Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 350, fig. 233.
1887. *Trichotropis borealis,* Mörch and Poulsen, MS. list in Geol. Mus., Copenhagen, no. 59 (unpublished).
1878. *Trichotropis borealis,* G. O. Sars, Moll. Reg. arct. Norv., pp. 163, 358.
1901. *Trichotropis borealis,* Friele og Greig, Norske Nordh. Exped. (Mollusca), pt. iii, p. 71.
1901. *Trichotropis borealis,* Brøgger, Norges geol. Undersøgelse, no. 31, p. 653, pl. xvii, fig. 17.
1913. *Trichotropis borealis,* Gignoux, Ann. Univ. Lyon, n.s. [1], vol. xxxvi, p. 548, pl. xiii, figs. 10, 11.
1915. *Trichotropis borealis,* Odhner, K. Svensk. Vet.-Akad. Handl., vol. liv, p. 173.

Specific Characters.—Shell rather small, fairly solid, turreted, sub-fusiform, pointed at each end; whorls about 6, somewhat convex, the last much the largest, longer than the spire; ornamented by strong projecting spiral ridges, four or five on the body-whorl, including the base, two on others, the upper ridge angulating the shell, also by very fine spiral lines in the interspaces and on the sloping shelf

below the suture; suture deep and sub-canaliculate; ridges generally spinous, beaded in the recent shell or when the epidermis is present; mouth large, narrowed below; outer lip thin, expanded, scalloped by the ribs; inner lip reflected on the pillar with a rather long sub-umbilical chink behind it; canal short, pointed, narrow.

Dimensions.—L. 16 mm. B. 9 mm.

Distribution.—*Recent:* British coasts, northern and local, from the Dogger Bank to the Shetlands, west of Scotland, Irish Sea, Lough Strangford, co. Galway.

Circumpolar: north-west coast of Norway, Hammerfest, Lofoten Islands, Faroes, Greenland, Labrador, New England coast, Behring Sea, Siberia, Nova Zembla, Spitzbergen, Kara Sea.

Fossil: Coralline Crag: Gedgrave, Sutton. Newbournian: Waldringfield. Butleyan: Butley. Iceland Crag. Isle of Man (Kendall), Wexford.

Pleistocene: Bridlington, Macclesfield, Moel Tryfaen, Garvel park, Bute.

Ficarazzi. *Cyprina*-beds, Christiania. Trondhjem (Øyen). Siberia, Canada, Labrador.

Remarks.—This species, the general range of which both as living and fossil is arctic and circumpolar, was one of the few and rare northern forms occurring in the Coralline Crag, whose molluscan fauna as a whole points to the existence at that period of comparatively warm conditions. A single characteristic specimen of it, however, was found by Brugnone in the Sicilian Pleistocene of Ficarazzi, which has recently been figured by M. Gignoux (*op. cit.*). It seems to have been very rare in the Anglo-Belgian basin during the Pliocene epoch, having been reported from two Red Crag localities only—Waldringfield and Butley. This may be due perhaps to its having been more or less a deep-sea species. Mr. Friele dredged it during the North Atlantic Expedition at various depths to about 400 fathoms.

One of the specimens here figured is from the Coralline Crag and belongs to the Sedgwick Museum, the other, which is a larger and stronger form, comes from Ipswich and was found at Waldringfield. With them I give for comparison a recent shell from Tromsö.

Trichotropis Kröyeri, R. A. Philippi. Plate XLIV, fig. 35.

1845. *Trichotropis Kröyeri,* Philippi, Zeitschr. f. Malakoz., vol. v, p. 175.

1849. *Cancellaria (?) arctica,* Middendorff, Beitr. Malac. Ross., pt. ii; Mém. Acad. Imp. Sci. St. Petersb. [6], vol. vi, p. 441, pl. ix, figs. 11, 12, 15.

1851. *Trichotropis dolium,* Petit, Journ. de Conch., vol. ii, p. 20, pl. i, fig. 4.

1869. *Trichotropis (Iphinoe) Kröyeri,* Mörch, Ann. Soc. Roy. Malac. Belg., vol. iv (Mémoires), p. 14, no. 9.

1872. *Trichotropis arctica ?,* Dawson, Canadian Nat. (n.s.), vol. vi, p. 395.

1878. *Trichotropis Kröyeri*, Leche, K. Svensk. Vet.-Akad. Handl., vol. xvi, p. 47, pl. i, fig. 12.
1887. *Trichotropis Kröyeri*, Tryon, Man. Conch., vol. ix, p. 44, pl. viii, fig. 61.
1887. *Trichotropis Kröyeri*, Aurivillius, Vega Exped., Vet. Jakt. Stockholm, vol. iv, p. 328, pl. xii, figs. 12, 13.
1901. *Trichotropis Kroyeri*, Friele og Greig, Norske Nordh. Exped. (Mollusca), pt. iii, p. 71.

Specific Characters.—Shell small, thin, ovato-conical; whorls 5, convex, not carinated, the last tumid, much the largest; spire short, ending in a blunt point; ornamented by spiral ridges with exceedingly fine longitudinal lines in the interspaces and by inconspicuous lines of growth; mouth pyriform, angulated above and below; umbilical fissure wide and open; canal very short, pointed; outer lip rounded.

Dimensions.—Of Crag specimen, L. 8 mm. B. 6 mm.

Distribution.—*Recent:* Spitzbergen, Nova Zembla, Kara Sea, Behring Sea.
Fossil: Waltonian Crag: Little Oakley (unique). Montreal (Dawson).

Remarks.—The small fossil here represented was found at Oakley. It agrees more or less closely with the specimen figured by Leche (*op. cit.*) except that it is considerably smaller.

T. Kröyeri is an arctic form which has not been hitherto reported from any Pliocene horizon. Sir J. W. Dawson gives it with a ? as *T. arctica*, from a Pleistocene deposit at Montreal, where he says it is very rare.

Trichotropis insignis, Middendorff. Plate XLIV, fig. 39; var. **Woodii,** nov., fig. 40.

1848. *Trichotropis insignis*, Middendorff, Mém. Acad. Imp. Sci., St. Petersb. [6], vol. vi, p. 436, pl. x, figs. 7, 8, 9.
1848–74. *Trichotropis borealis*, var. *incrassata*, S. V. Wood, Mon. Crag Moll., pt. i, p. 67, pl. xix, fig. 11, 1848; *T. insignis*, 1st Suppl., pt. ii, p. 207, 1874.
1856. *Trichotropis insignis*, Carpenter, Rep. Brit. Assoc. (Cheltenham), pp. 217, 223, 328.

Specific Characters.—Shell thin and fragile, ovato-turreted; whorls 6, carinated, flattened above, with a wide sloping shelf below the suture, the last much the largest; ornamented by rather rough irregular spiral ridges, reaching the suture, two or three of them more prominent than the others, with finer ones in the interspaces and upon the shelf, together with numerous indistinct costæ in the lines of growth; spire short, small, rapidly diminishing upwards towards a blunt spire; suture deep and channelled; mouth very large and wide, greatly expanded; outer lip thin, rounded, forming with the inner lip a continuous and glazed peristome; umbilicus long and narrow.

Dimensions.—L. 16 mm. B. 12 mm.

Distribution.—Recent: Alaska, Behring Sea.

Fossil: Pleistocene: Bridlington.

Remarks.—In 1848 Wood figured a fossil from Bridlington as *T. borealis*, var. *incrassata* (*op. cit.*) which afterwards, in the 2nd part of his 1st Supplement (1874), he referred to a recent Behring Sea species, *T. insignis*, Middendorff. There are three specimens in the Sedgwick Museum at Cambridge, evidently the same as Wood's shell, which, though not agreeing altogether with Middendorff's figures, belong to the same group, approaching to his *T. insignis* more nearly than to the British *T. borealis.* I figure one of the Bridlington fossils under the name adopted by Wood, but as a variety, and with it a typical example of the recent Behring Sea species from Alaska which Dr. Dall has kindly sent me. The latter is larger than those from Bridlington, and the mouth is wider and much more expanded. Our Bridlington fossils have a general resemblance to Dr. Dall's species and may be regarded, perhaps, as a slender variety of it. They seem to me more nearly related to the latter than to *T. borealis.* Grouping it with *T. insignis*, I adopt for the present shell the varietal name of *Woodii.*

Genus **TORELLIA**, Lovén in Jeffreys, 1867.

Torellia vestita (Jeffreys).

1859–85. ***Recluzia aperta***, Jeffreys, Ann. Mag. Nat. Hist. [3], vol. iii, p. 114, pl. iii, fig. 22, 1859; ***Torellia vestita***, Brit. Conch., vol. iv, p. 244, pl. iv, fig. 1, 1867; vol. v, pl. lxxix, fig. 5, 1869; Proc. Zool. Soc., p. 46, 1885.

1875–1901. ***Torellia vestita***, Friele, Christ. Vid.-Selsk. Forhandl., p. 62, pl. i, fig. 8, 1875; Norske Nordh. Exped. (Mollusca), pt. iii, p. 70, 1901.

1878. ***Torellia vestita***, G. O. Sars, Moll. Reg. arct. Norv., pp. 162, 358, pl. xxii, fig. 1.

1882. ***Torellia vestita***, Verrill, Trans. Conn. Acad., vol. v, p. 521, pl. xlvii, fig. 5.

1915. ***Torellia vestita***, Johnson, Bost. Soc. Nat. Hist., Occ. Papers, vol. vii; Fauna of New England, pt. xiii (Mollusca), p. 125.

Specific Characters.—Shell small, solid, naticiform, whorls 5—6, convex, rapidly enlarging, the last tumid, much the largest, five-sixths of the total length; spire very short, ending in a blunt point; suture deep and channelled; mouth large, subcircular; peristome continuous; outer lip with a sharp edge; inner lip folded back upon the pillar with a small protuberance below; basal groove very short; umbilical chink small, narrow, and oblique, partly concealed by the reflection of the inner lip.

Dimensions.—L. 12 mm. B. 10 mm.

Distribution.—Recent: Shetland, the west of Ireland, Norwegian coast from

Stavanger to the Lofoten Islands, the Faroe Channel. Massachusetts, Gulf of Maine.

Fossil: Wexford gravels, Blackwater.

Remarks.—While the present part of this Memoir is in the press, Mr. Bell has received from Father Codd a parcel of shelly material from the Wexford gravels, in which he has found a perfect though water-worn specimen of this interesting shell. Rare as a recent form, it has only been recorded under the above name as a fossil, so far as I know, from that locality.[1] *T. vestita* was originally described by Jeffreys, as both generically and specifically new, from a single example found on the east coast of Shetland. It has since been discovered, during the expedition of the 'Lightning and Porcupine,' off the coasts of Norway and from those of New England. It was at first referred to the Cancellariidæ, but is now more generally grouped with *Trichotropis*. It is unfortunately too late to figure the Wexford fossil in the present issue, but I hope to do so in my next Part.

In his description of the type specimen of this species, Jeffreys remarks that it is ornamented by five spiral and longitudinal striæ, but in his figures these are shown to be of an inconspicuous character. The Wexford shell is without sculpture but, as stated above, it appears to be water-worn.

Genus **APORRHAIS**, Dillwyn, 1823.

Aporrhais pes-pelicani (Linné). Plate XLI, figs. 26—29.

1758. *Strombus pes-pelicani*, Linné, Syst. Nat., ed. x, p. 742, no. 422.

1829. *Rostellaria pes-pelicani*, J. Sowerby, Min. Conch., vol. vi, p. 109, pl. dlviii, fig. 1.

1848–72. *Aporrhais pes-pelicani*, S. V. Wood, Mon. Crag Moll., pt. i, p. 25, pl. ii, fig. 4, 1848; 1st Suppl., pt. i, p. 49, 1872.

1852. *Chenopus anglicus*, D'Orbigny, Prod. Paléont. Strat., vol.iii, p. 59, no. 1031.

1852. *Chenopus pes-pelicani*, Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 194, pl. xviii, figs. 2, 3.

1853. *Aporrhais pes-pelicani*, Forbes and Hanley, Brit. Moll., vol. iii, p. 188, pl. lxxxix, fig. 4.

1863–71. *Aporrhais pes-pelicani*, Jeffreys, Rep. Brit. Assoc. (Newcastle-on-Tyne), p. 77, 1863; Brit. Conch., vol. iv, p. 250, 1867; vol. v, p. 216, pl. lxxx, fig. 1, 1869; in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, pp. 142, 486, 1871.

1873–5. *Chenopus pes-pelicani*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 350, no. 230, 1873; vol. v, p. 280, no. 89, 1874; vol. vi, p. 344, no. 432, 1875.

1874–95. *Chenopus pes-pelicani*, Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, pp. 260 *et seq.*, 1874; vol. xiv, p. 74, 1879; vol. xvii, p. 154, 1882; vol. xix, pp. 9, 191, 1884; Bull. Soc. Belge Géol., vol. vi (Mémoires), pp. 123, 133, 147, 1892; vol. ix, p. 131, 1895.

1881. *Chenopus pes-pelicani*, var. *anglica*, Nyst, Conch. Terr. Tert. Belg., p. 80, pl. vi, fig. 11.

1884. *Aporrhais pes-pelicani*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss, vol. i, p. 218, pl. xxiv, figs. 1—5.

[1] In Jeffreys' opinion the *Choristes elegans* of Carpenter from the post-Tertiary of Montreal approaches it, but Sir J. W. Dawson thought they were not the same.

1890–3. *Aporrhais pes-pelicani*, Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 190, no. 2131, 1890; Moll. Terr. Terz. Piem., pt. xiv, p. 28, pl. ii, figs. 28—37, 1893.

1896. *Chenopus pes-pelicani*, Bernays, Bull. Soc. Belg. Géol., vol. x (Mémoires), p. 129.

1901. *Aporrhais pes-pelicani*, Brøgger, Norges geol. Undersøgelse, no. 31, p. 661, pl. ix, fig. 5.

1908. *Aporrhais pes-pelicani* and vars., Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iv, p. 12, pl. ci, figs. 10—15; pl. cii, figs. 1—13; pl. ciii, figs. 1—6.

1912. *Aporrhais pes-pelicani*, Tesch, Med. v. d. Rijks. v. Delfstoffen., no. iv, p. 76, no. 182.

1913. *Chenopus pes-pelicani*, Cerulli-Irelli, Palaeont. Ital., vol. xvii, p. 275, pl. xxvi, figs. 29—31.

Specific Characters.—Shell solid, elongate, turreted, irregularly triangular, varying in size, with an acuminated spire and a compressed apex; whorls 10—12, convex, subangulate in the middle, with a single row of longitudinal plications on the keel of all but the last whorl, on which there are two or three, the upper one the largest; the plications are nodulous and prominent on the lower, and smaller and more numerous on the upper whorls; ornamented also by very fine spiral lines which extend to the base of the shell; outer lip expanded into a three- to four-fingered wing, along the middle of each finger of which the spiral lines of nodules extend, although they are smaller and more numerous than on the whorls, the upper finger running upwards along the spire but diverging from it, the fingers having a strong groove on the under side; the outer lip extends also to the base, where it forms a triangular beak continuous with the rest of the wing; inner lip spread over the wing and the basal beak, behind which it is folded so as to form a slight concavity.

Dimensions.—L. 45 mm. B. (not including the wings) 14 mm. Specimens from the Crag are usually smaller.

Distribution.—*Recent:* British coasts, North Atlantic from Finmark to Gibraltar, Iceland, Lofoten Islands. Mediterranean, Adriatic, Ægean.

Fossil: Lenham. Coralline Crag: Gedgrave, Ramsholt, Gomer, Sutton, Boyton. Waltonian: Walton-on-Naze, Beaumont, Little Oakley. Newbournian: *passim.* Butleyan: Bawdsey, Butley. Icenian: Aldeburgh, Suffolk, Thorpe near Norwich. Isle of Man, Wexford gravels. Pleistocene: March, Nar valley. Generally diffused in the Pleistocene deposits of England, Scotland and Ireland.

Waenrode bed, Diestien, Casterlien (*zone à Isocardia cor*), Scaldisien, Poederlien: Belgium. Scaldisien: Holland (Lorié).

Miocene: central Europe.

Lower Pliocene: Roussillon, Biot, Piedmont.

Upper Pliocene: Piedmont, Monte Mario, Bologna, Livorno, Caltabiano, Altavilla.

Pleistocene: Sicily, widely diffused. Christiania (Brøgger), Trondhjem (Øyen), Uddevalla. Eemien deposits: Holland (Lorié).

Remarks.—Much difference of opinion exists as to the respective priority of the generic terms *Aporrhais* and *Chenopus.* I adopt the former, which is the one

generally used by English Conchologists and by the Committee of the Conchological Society of Great Britain.

Beside the present species, widely diffused and fairly abundant in British seas during the various stages of the Pliocene and Pleistocene epochs, as it is at the present day, and a small form which appears to correspond more or less nearly with a Miocene variety and is described in the next paragraph, I have two different but nearly allied species in my collection from the Antwerp Crag. Possibly these may have been overlooked by English collectors, or, if not, they may turn up at any time. It seems to me desirable, therefore, to figure my Belgian specimens in order to call attention to the subject and to show wherein they differ from the characteristic English form.

A. pes-pelicani is included by Prof. Brøgger in the list of Lusitanian shells before referred to, which he finds, mixed with arctic and boreal mollusca, in the later stages of the Pleistocene deposits of the Christiania region. It occurs at many localities of the Sicilian and the English Pleistocene.

MM. Bucquoy, Dautzenberg and Dollfus suggest that *A. pes-pelicani* may be a descendant of the Oligocene species *A. speciosa*, Schlotheim.

As stated above, most of the Crag specimens of *A. pes-pelicani* are smaller than the recent British shell, averaging from 25 mm. to 35 mm. in length. These Nyst identified in 1881 (*op. cit.*, p. 81) with the *Chenopus anglicus* of D'Orbigny (*op. cit.*); those figured by Sowerby, Wood and Nyst are of this type.

Var. **minor**, Bucquoy, Dautzenberg and Dollfus. Plate XLI, fig. 30.

1852. *Chenopus pes-pelicani*, Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 194, pl. xviii, fig. 4.
1881. *Chenopus pes-pelicani*, Fontannes, Moll. plioc. Vall. du Rhone, vol. i, p. 153, pl. ix, fig. 3.
1884. *Aporrhais pes-pelicani*, var. *minor*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 220, pl. xxiii, fig. 11.
1886. *Aporrhais pes-pelicani*, var. *minor*, Dollfus et Dautzenberg, Feuilles des jeunes Nat., vol. xvi, p. 105.
1893. *Chenopus pes-pelicani*, Sacco, Moll. Terr. Terz. Piem., pt. xiv, p. 30.

Varietal Characters.—Much smaller than the type, with shorter wings and spire and finer sculpture.

Dimensions.—L. 20 mm.

Distribution.—*Recent:* Mediterranean.

Fossil: Coralline Crag: Boyton. Waltonian: Little Oakley. Probably at other localities in the Crag.

Miocene: Touraine, Vienna basin, Italy.

Lower Pliocene: Italy, Rhone valley.

Upper Pliocene: Italy (Astigiano).

Remarks.—The Coralline Crag specimen from Boyton figured under this name corresponds with one from the Miocene of the Vienna basin given by Hörnes and with a Pliocene fossil from the Rhone valley by Fontannes. It seems to be a dwarf form of *A. pes-pelicani* dating back to the Miocene period, being also reported by Prof. Sacco from deposits of that age at Cuneo in Piedmont and from the Astian and Piacenzian of the Ligurian coast, as well as from the Faluns of Touraine by MM. Dollfus and Dautzenberg, and as recent by the same authority from Roussillon.

Prof. Sacco regards this variety as characteristic of somewhat deeper water conditions than those of the type form.

Aporrhais Uttingerianus (Risso). Plate XLI, figs. 31, 32.

1826. *Rostellaria uttingerianus*, Risso, Hist. nat. Europ. mérid., vol. iv, p. 225, no. 591.
1836–44. *Chenopus pes-graculi*, Philippi, Enum. Moll. Sic., vol. i, p. 215, 1836; vol. ii, p. 185, 1844.
1852. *Chenopus pes-pelicani* (part), Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 194, pl. xviii, figs. 2, 3.
1870. *Aporrhais pes-graculi*, A. Bell, Journ. de Conch., vol. xviii, p. 350, no. 350.
1873–6. *Chenopus Uttingeri*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 350, no. 231, 1873; vol. v, p. 280, no. 90, 1874; vol. vii, p. 8, no. 433, 1876.
1878. *Chenopus Uttingeri*, de Stefani e Pantanelli, Bull. Soc. Malac. Ital., vol. iv, p. 136.
1881. *Chenopus uttingerianus*, Fontannes, Moll. plioc. Vall. du Rhone, vol. i, p. 155, pl. ix, fig. 4.
1890–3. *Aporrhais pes-graculi*, and vars., Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 190, no. 2130, 1890; *Chenopus uttingerianus* and vars., Moll. Terr. Terz. Piem, pt. xiv, p. 23, pl. ii, figs. 21—25, 1893.
1895. *Chenopus Uttingerianus*, Vinassa de Regny, Boll. Soc. Malac. Ital., vol. xx, p. 21, pl. iii, figs. 1—12.
1913. *Chenopus Uttingerianus*, Cerulli-Irelli, Palaeont. Ital., vol. xvii, p. 274, pl. xxvi, figs. 26—28.
1913. *Chenopus uttingerianus*, Gignoux, Ann. Univ. Lyon, n. s. [1], vol. xxxvi, p. 541.

Specific Characters.—Shell turreted, generally smaller than *A. pes-pelicani*; spire short and wide, conical, at the apex forming an angle of about 45°; whorls 7–8, the upper ones rounded, the lower angulated with fine or nearly obsolete denticulation; mouth oblique, ending in a narrow canal, turning to the left.

Dimensions.—L. 25—33 mm. B. 8—12 mm.

Distribution.—Not known living.

Fossil: Scaldisien: Antwerp.

Miocene: north Germany, Vienna basin, Italy (Tortoniano, Elveziano).

Lower Pliocene: Biot, Piedmont, Tuscany. Rhone valley, Roussillon and elsewhere in southern France.

Upper Pliocene: Monte Mario, Bologna, Orciano, Altavilla, Caltabiano, Gerace.

Pleistocene: Taranto, Castroreale, Gravina, Girgenti, Nizzeti.

Remarks.—This species, only known as fossil and exceedingly abundant in the Piacenziano of northern Italy, ranges from the Miocene to the Sicilian Pleistocene. I have a small specimen in my collection from the Scaldisien of Antwerp which I

have figured on the chance of its turning up in the East Anglian Crag. It may be easily recognised by its short, obtusely conical spire and the fine or nearly obsolete denticulation of the keel.

Aporrhais Serresianus (Michaud). Plate XLI, fig. 33.

1828. *Rostellaria serresiana*, Michaud, Bull. Soc. Linn. Bordeaux, vol. ii, p. 120, pl. i, figs. 3, 4.
1844. *Chenopus Serresianus*, Philippi, Enum. Moll. Sic., vol. ii, p. 185, pl. xxvi, fig. 6.
1873–6. *Chenopus Serresianus*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 350, no. 232, 1873; vol. v, p. 280, no. 91, 1874; vol. vii, p. 8, no. 434, 1876.
1874. *Aporrhais pes-pelicani*, var. *Serresianus*, S. V. Wood, Mon. Crag Moll., 1st Suppl., pt. ii, p. 180, add. pl., fig. 6.
1878. *Aporrhais Serresianus*, G. O. Sars, Moll. Reg. arct. Norv., pp. 192, 359, pl. xiii, fig. 4; pl. xxii, fig. 7.
1884. *Aporrhais Serresianus*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 220, pl. xxiii, figs. 9, 10.
1890. *Chenopus Serresianus*, Carus, Prod. Faun. Medit., vol. ii, p. 367.
1892. *Aporrhais Serresianus*, Locard, Coq. mar. Côtes de France, p. 124.
1898. *Aporrhais Serresianus*, Posselt, Medd. om Grønl., p. 214.
1901–3. *Aporrhais serresianus*, Friele og Grieg, Norske Nordh. Exped. (Mollusca), pt. iii, p. 79.
1907. *Chenopus serresianus*, Scalia, Atti Accad. Gioen. Sci. Nat. Catania, vol. xx, p. 34, no. 280.
1908. *Aporrhais serreseanus*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iv, p. 20, pl. civ, figs. 1—4.
1911. *Aporrhais serresianus*, Marshall, Journ. of Conch., vol. xiii, p. 183.
1913. *Chenopus serresianus*, Gignoux. Ann. Univ. Lyon, n.s. [1], vol. xxxvi, p. 542.

Specific Characters.—Shell resembling that of *A. pes-pelicani* but thinner and more delicate, the spire being shorter and more slender; whorls 9 to 10, convex, regularly diminishing in size upwards, the last drawn out into a long, very fine and narrow spine-like process or finger which is curved towards the end; the upper finger projects beyond the spire, and is closely attached to it; angulation of the whorls much less prominent, the tuberculate ornaments being smaller and more numerous, especially on the last whorl; suture distinct but not so deep as in *A. pes-pelicani.*

Dimensions.—L. 45 mm. B. (without the wings) 12 mm.

Distribution.—*Recent:* W. and S.W. of Ireland, Shetlands, Shetland-Faroe Channel, Lerwick, Butt of Lewis, Valentia, North Sea, English Channel. Atlantic coasts of Spain, France and Norway to Lofoten Islands. Mediterranean, Adriatic, Ægean. Greenland, Davis Strait.

Fossil: Coralline Crag: Gomer, Broom Hill.

Lower Pliocene: Italy.

Upper Pliocene: Italy, Sicily.

Pleistocene: Sicily—Ficarazzi, Barcellona-Castroreale.

Remarks.—This distinct form, which seems to be less abundant, whether as

recent or fossil, than *A. pes-pelicani*, can be easily distinguished from it. Wood describes an immature specimen from the Coralline Crag. I have figured a recent and perfect shell from Bergen for the purpose of comparison. I have not noticed it at Oakley but probably it may be discovered at some other Crag localities if specially looked for. It was obtained by the Valorous Expedition in Davis Strait. The var. *Macandreæ* has been found in the Scaldisien of Antwerp.

Mr. Marshall states (*op. cit.*) that *A. Serresianus* has been dredged on the W. and S.W. coasts of Ireland, off the Shetlands (85—1230 f.), in the Shetland-Faroe Channel, in the North Sea to the N.E. of Aberdeen and in the English Channel—in the latter locality from 358 to 690 fathoms ('Porcupine' Expedition).

Var. **Macandreæ**, Jeffreys. Plate XLI, fig. 34.

1853. *Aporrhais pes-carbonis*, Forbes and Hanley, Brit. Moll., vol. iii, p. 186, pl. lxxxix, figs. 5, 6.

1867–69. *Aporrhais Macandreæ*, Jeffreys, Brit. Conch., vol. iv, p. 253, 1867; vol. v, p. 216, pl. lxxx, fig. 2, 1869.

1899. *Aporrhais Macandreæ*, Norman, Ann. Mag. Nat. Hist. [7], vol. iv, p. 151.

1908. *Aporrhais serreseanus, macandreæ*, Kobelt, Icon. schalentrag. europ. Meeresconch., vol. iv, p. 22, pl. civ, figs. 5—10.

1911. *Aporrhais serresianus*, var. *macandreæ*, Marshall, Journ. of Conch., vol. xiii, p. 183.

Varietal Characters.—Smaller than the type and more delicately sculptured, the spire is shorter and less tapering, the whorls are fewer and rounded rather than angulate.

Dimensions.—L. 24 mm. B. 8 mm.

Distribution.—*Recent:* Shetlands, Faroe-Shetland Channel, west Coast of Norway, Lofoten Islands, west Greenland, Bay of Biscay.

Fossil: Scaldisien: Antwerp.

Pleistocene: Ficarazzi.

Remarks.—Originally described by Jeffreys as a distinct species, it has since been regarded by Prof. Kobelt as a northern and deep sea variety of *A. Serresianus*, from which it differs but little, except in size and its less prominent sculpture, apparently bearing a similar relation to that species as the var. *minor* of *A. pes-pelicani* does to the normal form. Mr. Marshall states that as a recent British shell it is confined to a limited area in the Shetland seas.

The specimen now figured is from the Scaldisien of Antwerp. I have not found it at Oakley, but it should be looked for in the East Anglian Crag. The Marchese di Monterosato, who regards it as a distinct variety, reports it from the Sicilian Pleistocene of Ficarazzi (*fide* Kobelt).

Genus **TURRITELLA**, Lamarck, 1799.

Turritella tricarinata (Brocchi). Plate XLIV, figs. 7—9.

1814. *Turbo tricarinatus*, Brocchi, Conch. foss. subap., vol. ii, p. 374, pl. vi, fig. 21.
1873–6. *Turritella tricarinata*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 356, no. 335, 1873; vol. v, p. 282, no. 121, 1874; vol. vii, p. 100, no. 636, 1876.
1880. *Turritella communis*, var. *ariesensis* (pt.), Fontannes, Moll. plioc. Vallée du Rhone, vol. i, p. 199, pl. xi, fig. 4.
1882. *Turritella tricarinata*, von Koenen, Nord-deutsch. Mioc. Moll.-fauna, pt. ii, p. 283, no. 188.
1885. *Turritella terebra*, Lorié, Arch. Mus. Teyler [2], vol. ii, pp. 185, 230, pl. vii, fig. 4.
1889–95. *Turritella tricarinata*, Sacco, Boll. Soc. Geol. Ital., vol. viii, p. 353, no. 1901, 1889; Moll. Terr. Terz. Piem., pt. xix, p. 5, pl. i, figs. 14—19, 1895.
1907. *Turritella tricarinata*, Ravn, Kongl. Dansk Vid. Selsk. Skrift., vol. vii, p. 296, pl. iii, fig. 16.
1912. *Turritella tricarinata*, Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 158, pl. xxiv, figs. 20—25.
1912. *Turritella tricarinata*, Cossmann, Ess. Paléoconch. compar., vol. ix, p. 112.
1913. *Turritella tricarinata*, Gignoux, Ann. Univ. Lyon, n. s. [1], vol. xxxvi, p. 551.

Specific Characters.—Shell turreted, subulate, smaller and more delicate than *T. incrassata;* whorls about 10, decidedly convex; ornamented by three acute, distinct, and nearly equidistant spiral ridges, the middle one being the strongest and most prominent, with finer lines between them; spire elongate, slender, ending in a fine point; suture deep and well marked; mouth rounded.

Dimensions.—L. 30 mm. B. 10 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: abundant. Waltonian: Walton-on-Naze, Beaumont, Little Oakley. Newbournian: Waldringfield, probably elsewhere.

Miocene: Denmark, north Germany, Italy.

Lower Pliocene: Italy—Ligurian coast, Piedmont.

Upper Pliocene: Bologna, Monte Mario, Piedmont, Liguria, Altavilla, Dutch borings.

Pleistocene: Monte Pellegrino, Ficarazzi, Reggio, Naso, Bologna.

Remarks.—The present Crag form, which appears to correspond with the Italian fossil *T. tricarinata*, has not been reported hitherto from the Anglo-Belgian basin. Its occurrence at the Coralline and Waltonian horizons, especially at Oakley where I have found it in great abundance, leads me to think that it has been overlooked by collectors, probably under the impression that specimens of it were dwarf or immature forms of *T. incrassata.* The latter, however, belongs to a different group, the sub-genus *Haustator* described below. The sculpture of *T. tricarinata*, moreover, is different; it is a smaller and more delicate shell than *T. incrassata*, allied to the recent British *T. communis.* Some authorities consider the latter identical with it, others that the two are varieties of one species. For reasons given in the following section I prefer to regard them as specifically distinct, not

only because they differ in form and ornament, as will be seen in the figures now given (Pl. XLIV, figs. 1 to 9), but also in their range both of time and space, the one *T. triplicata* being a southern form widely diffused in Miocene strata but now extinct, the other *T. communis* a shell with a somewhat more northerly distribution, indicating a comparatively late appearance in the Crag basin and becoming subsequently an exceedingly abundant Pleistocene species which is still living. Brocchi and Prof. Sacco describe these two forms as distinct in the Italian Pliocene, either as specific or varietal, while Seguenza gives both of them from different horizons of the Sicilian deposits.

I have figured a fossil specimen of *T. tricarinata* from Sicily with others from the English Crag to show the identity of the latter with the Mediterranean fossils.[1] In *T. tricarinata* the spiral sculpture is more delicately and distinctly chiselled than in *T. communis* and is decidedly tricarinate.

Var. **bicincta** (S. V. Wood). Plate XLIV, fig. 10.

1842–48. *Turritella bicincta,* S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix, p. 534, 1842 ; *T. incrassata,* var. *bicincta,* Mon. Crag Moll., pt. i, p. 75, pl. ix, fig. 7 *d,* 1848.

1879. *Turritella incrassata,* var. *bicincta,* Cogels and Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. xiv, p. 71.

1912. *Turritella tricarinata,* var. *bicingulata,* Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 159, pl. xxiv, fig. 26.

Varietal Characters.—Corresponds generally with *T. tricarinata,* but it has two well-marked prominent and equal spiral ridges in the centre of each whorl instead of three, as well as some excessively fine lines, hardly visible without the aid of a lens. On the lowest whorls the base is spirally thickened immediately above the suture, so as to present the appearance of a third ridge, which angulates the base of the shell.

Dimensions.—L. 25 mm. B. 8 mm.

Distribution.—Not recorded living.

Fossil: Coralline Crag. Waltonian: Walton-on-Naze, Little Oakley (abundant). Newbournian: Felixstow, probably elsewhere. Butleyan: Butley. Zone *à Isocardia cor:* Antwerp, Belgium.

Remarks.—This shell is fairly common in the earliest horizons of the Crag, occurring abundantly with the type form of *T. tricarinata,* both in the Coralline Crag and in the Waltonian of Walton and Oakley. It was regarded at first by Wood as a distinct species, but afterwards both by him and by M. Van den Broeck as a variety of *T. incrassata.* Its affinities, however, are with *T. tricarinata,* resembling that species in size, form, and general appearance. A similar shell

[1] Dr. Lorié's figure of *T. terebra* (*op. cit.*) represents a typical specimen of *T. tricarinata.*

from the Upper Pliocene of Monte Mario has been figured by Sign. Cerulli-Irelli (*op. cit.*), which he also associates with *T. tricarinata* under the varietal name of *bicingulata*.

Wood's var. *bicincta* (*op. cit.*) is the same as our present shell. Nyst's var. *bicincta*[1] is, I consider, a different species.

Turritella communis, Risso. Plate XLIII, fig. 15; Plate XLIV, figs. 1—6.

1826. *Turritella communis,* Risso, Hist. nat. Europ. mérid., vol. iv, p. 106, no. 246, fig. 37.
1842–72. *Turritella terebra,* S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix, p. 534, 1842; *T. communis,* Mon. Crag Moll., pt. i, p. 74, pl. ix, fig. 9, 1848; *T. terebra,* 1st Suppl., pt. i, p. 53, 1872.
1853. *Turritella communis,* Forbes and Hanley, Brit. Moll., vol. iii, p. 172, pl. lxxxix, figs. 1—3.
1867–9. *Turritella terebra,* Jeffreys, Brit. Conch., vol. iv, p. 80, 1867; vol. v, p. 209, pl. lxx, fig. 6, 1869.
1878. *Turritella terebra,* G. O. Sars, Moll. Reg. arct. Norv., pp. 185, 359.
1873–6. *Turritella communis,* Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 356, no. 334, 1873; vol. v, p. 282, no. 120, 1874; vol. vii, p. 100, no. 642, 1876.
1884. *Turritella communis,* and vars., Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 224, pl. xxviii, figs. 6—11.
1890. *Turritella communis,* Carus, Prod. Faun. Medit., vol. ii, p. 354.
1892. *Turritella communis,* Locard, Coq. mar. Côtes de France, p. 125.
1901. *Turritella terebra,* Brøgger, Norges geol. Undersøgelse, no. 31, p. 660, pl. ix, fig. 9.
1903. *Turritella terebra,* Lamplugh, Mem. Geol. Surv. (Isle of Man), p. 473.
1912. *Turritella terebra,* Tesch, Med. v. d. Rijks. v. Delfstoffen, no. iv, p. 72, no. 164.
1912. *Turritella tricarinata,* var. *communis,* Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 159, pl. xxiv, figs. 30—33.
1913. *Turritella communis,* Gignoux, Ann. Univ. Lyon, n. s. [1], vol. xxxvi, p. 552.

Specific Characters.—Shell solid, slender, elongate, with a narrow and angulated base; whorls more or less convex, compressed on each side of the suture, regularly diminishing in size to an acute point; generally ornamented by fine, rather inconspicuous spiral ridges, three on the upper whorls, more on the lower, some of them still finer, with closely-set striæ in the lines of growth; suture fairly deep; mouth rounded; outer lip incurved above, angulated at the base; inner lip reflected on the pillar.

Dimensions.—L. 35—50 mm. B. 10—15 mm.

Distribution.—*Recent:* generally diffused in British seas and on the Atlantic coasts from Morocco to the Lofoten Islands. Iceland. Mediterranean (*passim*), Adriatic, Ægean, Asia Minor.

Fossil: Newbournian Crag: Sutton? Butleyan: Butley; probably elsewhere in the upper zones of the Red Crag. Icenian: Norwich, Chillesford and Weybourne horizons, common at most localities. Isle of Man. Wexford.

[1] Conch. Terr. Tert Belg., p. 83, pl. vi, fig. 12 *g*, 1881.

Pleistocene: Middle glacial sands: Billockby, Clippesby, Hopton. Bridlington. Selsey, Nar Valley, March gravels, Blackpool, Kelsey Hill and many other glacial and post-glacial deposits in Great Britain and Ireland.

Upper Pliocene: Italy, Sicily, Holland.

Pleistocene: Italy, Sicily, Christiania *Tapes*-banks (Brøgger), Trondhjem (Øyen).

Remarks.—As stated above, I am disposed to regard the recent *T. communis* as specifically distinct from the extinct and fossil *T. tricarinata* of the earlier zones of the Crag and of the Mediterranean deposits. This view has not been generally accepted, and some confusion has arisen in consequence. Whatever we call them, whether varieties of one species or by different specific names, they are not the same, having a zonal value which, from a stratigraphical point of view, is important and should not be lost sight of.

The one, *T. tricarinata*, is a comparatively old form, going back, according to Prof. Sacco, to Miocene times, ranging upwards through the Italian Pliocene to the Pleistocene of Sicily and Calabria, but not recorded as now living in the Mediterranean or elsewhere; similarly, although it is exceedingly common in the Coralline and Waltonian horizons of the Crag, it gradually disappeared from the later zones and is not found in our Pleistocene beds.

On the other hand, I have no note of the occurrence of *T. communis* in the Coralline or Waltonian Crag, and it was unknown from them to Wood, Jeffreys, the brothers Bell, and C. Reid. It was not until the latest or Icenian stage of the Crag that it began to establish itself in any abundance in the East Anglian area, but in the British Pleistocene it became one of the most common and characteristic fossils.

T. tricarinata, moreover, was a southern form which died out in the Crag basin as the climate became colder, *pari passu* with the arrival in it of the northern and arctic mollusca. *T. communis*, on the contrary, has a range comparatively northern, living on the Norwegian coast as far north as the Lofoten Islands and in Iceland, flourishing in these latitudes under the glacial and subglacial conditions of the Pleistocene epoch. Prof. Brøgger reports it from the post-glacial beds of the Christiania fiord, and Dr. Øyen from those of Trondhjem.

It may be interesting to notice that while it has not been found at St. Erth, it occurs rather plentifully in the newer western deposits of Wexford and the Isle of Man. The spiral sculpture of specimens from Wexford and from our Pleistocene deposits is generally coarser than that of the recent British shell; see also Brøgger, *op. cit.*, pl. ix, fig. 9.

Such facts illustrate the importance of the careful study of varieties, or of supposed varieties, which may sometimes lead to results of considerable interest.

Jeffreys employed Linné's specific name of *terebra* for the present shell, but MM. Bucquoy, Dautzenberg and Dollfus point out that his *Turbo terebra* was a species from the China seas (*op. cit.*, p. 225).

It does not seem to me that the fossil described by Prof. Sacco from the Italian Miocene and Pliocene, as *T. tricarinata*, var. *communis*,[1] is a characteristic specimen of the recent British shell; the *T. turris* of Hörnes, identified by him with the *T. terebra* of Zieten (non Gmelin), and with the *T. communis* of Bronn (non Risso)[2] is a different species.

Turritella erosa, Couthouy. Plate XLIV, fig. 15.

1838. *Turritella erosa,* Couthouy, Bost. Journ. Nat. Hist., vol. ii, p. 103, pl. iii, fig. 1.
1841–70. *Turritella erosa,* Gould, Rep. Invert. Mass., ed. 1, p. 267, 1841; ed. 2, p. 317, fig. 585, 1870.
1842. *Turritella polaris,* Möller, Ind. Moll. Groenl., p. 10.
1843. *Turritella erosa,* de Kay, Nat. Hist. New York, pt. v (Mollusca), p. 113, pl. vi, fig. 122.
1848–72. *Turritella clathratula,* S. V. Wood, Mon. Crag Moll., pt. i, p. 76, pl. ix, fig. 8, 1848; *T. erosa,* 1st Suppl., pt. i, p. 53, 1872.
1864. *Turritella erosa,* S. P. Woodward, Geol. Mag., vol. i, p. 53; in Gunn's Hist. Norfolk, ed. 3, p. 118.
1870. *Turritella polaris,* S. V. Wood, Jr., Quart. Journ. Geol. Soc., vol. xxvi, p. 93.
1872. *Turritella erosa,* Dawson, Canadian Nat. (n. s.), vol. vi, p. 389.
1877–84. *Turritella erosa,* Jeffreys, Ann. Mag. Nat. Hist. [4], vol. xix, p. 239, 1877; in Lamplugh, Quart. Journ. Geol. Soc., vol. xl, p. 319, 1884.
1880. *Turritella erosa,* Stewart, Proc. Belfast Nat. Field Club, Appendix, p. 174.
1898. *Turritella erosa,* Posselt, Medd. om Grønl., p. 218.
1915. *Turritella erosa,* Johnson, Bost. Soc. Nat. Hist., Occ. papers, vol. vii; Fauna of New England, pt. xiii, p. 122.
1917. *Turritella polaris,* A. Bell, Naturalist (Yorkshire), No. 722, p. 96.

Specific Characters.—Shell solid, turreted, elongato-conical; whorls about 10, but slightly convex; ornamented by from 3 to 5 rounded and closely-set spiral ridges with numerous indistinct lines of growth; spire regularly diminishing in size upwards; suture distinct, but not deep; mouth small, subcircular; base rounded.

Dimensions.—L. 24 mm. B. 8 mm.

Distribution.—Recent: (Circumpolar) Greenland, Labrador, Spitzbergen, Behring Sea, Sitka, Gulf of St. Lawrence to Cape Cod, Banks of Newfoundland. Japan.

Fossil: Pleistocene: England—Bridlington, Dimlington. Scotland—Elie, King Edward. Ireland—Ballyrudder. Labrador, Riviere du Loup, Montreal (?).

Remarks.—This species, an arctic and North American form, has not been recorded from the Crag, being known to English Palæontologists from Bridlington only. Sir J. W. Dawson gives it from the Pleistocene of Labrador and the St.

[1] Moll. Terr. Terz. Piem., pt. xix, p. 6, pl. i, fig. 15.
[2] Foss. Moll. Tert. Wien, vol. i, p. 423, pl. xliii, figs. 15, 16.

Lawrence region. It belongs to the small group of characteristic American mollusca which have been reported from the Pleistocene, but not from the Pliocene deposits of Great Britain.

Turritella turris, Basterot. Plate XLIV, figs. 11, 12.

1825. *Turritella turris*, Basterot, Mém. Soc. Hist. Nat. Paris, vol. ii, p. 29, pl. i, fig. 11.
1840. *Turritella turris*, Grateloup, Conch. foss. Terr. Tert. Bass. de l'Adour, vol. i (*Turritella*), pl. i, fig. 9.
1856. *Turritella turris*, Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 423, pl. xliii, figs. 15, 16.
1895. *Turritella turris* and vars., Sacco, Moll. Terr. Terz. Piem., pt. xix, p. 3, pl. i, figs. 1—10.
1912. *Turritella turris*, Cossmann, Ess. Paléoconch. compar., vol. ix, p. 112.

Specific Characters.—Shell turreted, strong and solid; whorls about 12, convex, excavated above, angulate below; spire elongate, slender, regularly tapering; spirally ornamented by 5 or 6 unequal ridges, the two lower ones being the most prominent, and by exceedingly fine striæ; suture deep and channelled; base of the whorls subangulated by the last ridge; base of the shell rounded and obscurely ridged.

Dimensions.—L. 45 mm. B. 12 mm.

Distribution.—Not known living.

Fossil: Waltonian Crag: Little Oakley.

Miocene: Touraine, Bordeaux, Vienna, Piedmont.

Remarks.—The worn specimen from Oakley figured under this name corresponds more or less closely with Basterot's original figure of the present species, and with a fossil from the Faluns of Touraine that I have received as *T. turris*. It may possibly be derivative in the English Crag, where broken fragments of it are occasionally met with. *T. turris* is a characteristic Miocene shell which, so far as I know, has not been reported hitherto from the Pliocene deposits. The Crag specimen I have figured under this name may be regarded as a somewhat doubtful identification. The Miocene fossil given for comparison is from the Faluns of Touraine.

Sub-genus **ZARIA**, Gray, 1847.

Turritella (Zaria) subangulata (Brocchi). Plate XLII, figs. 15, 16.

1814. *Turbo subangulatus*, Brocchi, Conch. foss. subap., vol. ii, p. 374, pl. vi, fig. 16.
1871. *Turritella subangulata*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 492.
1873-5 *Turritella subangulata*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 356, no. 336, 1873; vol. v, p. 282, no. 122, 1874; vol. vi, p. 100, no. 644, 1875.
1878. *Turritella subangulata*, de Stefani e Pantanelli, Bull. Soc. Malac. Ital., vol. iv, p. 148.

1879. *Turritella incrassata*, var. *subangulata*, S. V. Wood, Mon. Crag Moll., 2nd Suppl., p. 27, pl. ii, fig. 17.

1880. *Turritella subangulata*, Fontannes, Moll. plioc. Vall. du Rhone, vol. i, p. 196, pl. xi, fig. 1.

1882. *Turritella subangulata*, von Koenen, Nord-deutsch. Miocän. Moll.-fauna, pt. ii, p. 287, no. 192.

1886 *Turritella subangulata*, Dollfus et Dautzenberg, Feuilles des jeunes Nat., vol. xvi, p. 138.

1889–95. *Turritella subangulata*, Sacco, Boll. Soc. Geol. Ital., vol. viii, p. 353, no. 1904, 1889; *T.* (*Zaria*) *subangulata*, Moll. Terr. Terz. Piem., pt. xix, p. 9, pl. i, figs. 30, 31, 32, 1895.

1912. *Turritella* (*Zaria*) *subangulata*, Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 159, pl. xxiv, figs. 34, 35, 36.

1912. *Turritella* (*Zaria*) *subangulata*, Cossmann, Ess. Paléoconch. compar., vol. ix, p. 113, pl. ix, fig. 9.

1912. *Turritella subangulata*, Tesch, Med. v. d. Rijks. v. Delfstoffen, no. iv, p. 72, no. 165

Specific Characters.—Shell turriculate with an elongate and regularly conical spire; whorls 10 or 12, convex, ornamented by spiral lines or fine ridges varying in size, the central and more prominent one forming a distinct keel, and by inconspicuous and flexuous lines of growth, often nearly obsolete; suture slight; apex acute; inner lip extending over the pillar.

Dimensions.—L. 40—45 mm. B. 12—15 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Sutton. Waltonian: Walton-on-Naze, Little Oakley. Newbournian: Waldringfield. Probably elsewhere in Red Crag. Scaldisien: Holland.

Miocene: Touraine, North Germany, Italy, Portugal.

Lower Pliocene: Rhone valley, Biot, Piedmont.

Upper Pliocene: Piedmont, Bologna, Orciano, Livorno, Monte Mario, Reggio, Messina, Altavilla, Caltabiano.

Pleistocene: Santa Cristina, Monteleone, Naso, Barcellona-Castroreale.

Remarks.—Brocchi described two allied shells as *Turbo subangulatus* and *T. acutangulus*, but the last named is now generally considered a variety of the first, the difference between them being one of sculpture. As both of them have been reported from the Crag, I figure a specimen from the Italian Pliocene which may represent more or less nearly the latter form; the sub-generic term *Zaria*, of which *T. subangulata* is taken as the type, has been adopted for a group of the Turritellidæ with whorls angulated in the centre.

The specimen from the Coralline Crag figured by Wood as *T. incrassata*, var. *subangulata* (*op. cit.*) may probably represent the present species, as may also those from Oakley here represented; the sculpture of the latter, however, is somewhat coarser and the central angulation is more prominent than in Brocchi's type, but they correspond very closely with two of Prof. Sacco's varieties (*op. cit.*, figs. 31, 32).

Var. **mediocarinata** (de Gregorio). Plate XLII, fig. 17.

1814. *Turbo acutangulus*, Brocchi, Conch. foss. subap., vol. ii, p. 368, pl. vi, fig. 10.

1856. *Turritella subangulata*, Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 428, pl. xliii, figs. 5, 6,

1870. *Turritella acutangula*, A. Bell, Journ. de Conch., vol. xviii, p. 350, no. 357.
1875. *Turritella subangulata*, var. *acutangula*, Seguenza, Boll. R. Com. Geol. Ital., vol. vi, p. 100, no. 644.
1889. *Turritella mediocarinata*, de Gregorio, Natur. Sicil., vol. viii, p. 12.
1895. *Turritella (Zaria) subangulata*, var. *spirata*, Sacco, Moll. Terr. Terz. Piem., pt. xix, p. 10, pl. i, fig. 34.
1912. *Turritella (Zaria) subangulata*, var. *mediocarinata*, Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 160, pl. xxiv, fig. 37.

Varietal Characters.—Differs from the type in its much finer spiral sculpture and in the more distinct and sub-central angulation of the whorls.

Dimensions.—L. 45 mm. B. 12 mm.

Distribution.—Not known living.

Fossil: Miocene: Vienna basin, Touraine, North Italy.

Lower Pliocene: Biot, Ligurian coast.

Upper Pliocene: Asti, Bologna, Livorno, Orciano, Val d'Era, Caltabiano.

Pleistocene: Monte Pellegrino, San Giovanni, Monteleone, Taranto.

Remarks.—The shell from the Upper Pliocene of Sicily given under the present name for the purpose of comparison, seems to represent the *Turbo acutangulus* of Brocchi (*T. subangulata*, var. *acutangula* of later writers).[1]

It seems to me that the occurrence of this form in the English Crag is somewhat doubtful, the small specimen figured by Wood as *T. incrassata*, var. *acutangula* (Mon. Crag Moll., 2nd Suppl., p. 27, pl. ii, fig. 16) more probably representing the recent Mediterranean species, *T. decipiens*, described in the next paragraph.

Turritella (Zaria) decipiens (Monterosato). Plate XLIV, figs. 13, 14.

1879. *Turritella incrassata*, var. *acutangula*, S. V. Wood, Mon. Crag Moll., 2nd. Suppl., p. 27, pl. ii, fig. 16.
1878–1917. *Turritella decipiens*, Monterosato, Enum. e Sinon. Conch. medit., p. 29, 1878; Bull. Soc. Malac. Ital., vol. vi, p. 226, 1880; *T. (Haustator) decipiens*, Boll. Soc. Zool. Ital. [3], vol. iv, 1917.
1884–98. *Turritella decipiens*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 228, pl. xxviii, figs. 12–15, 1884; vol. ii, p. 796, 1898.
1890. *Turritella decipiens*, Carus, Prod. Faun. Medit., vol. ii, p. 354.
1913. *Turritella (Zaria) decipiens*, Gignoux, Ann. Univ. Lyon, n.s. [1], vol. xxxvi, p. 550.

Specific Characters.—Shell small, slender, elongato-conical; whorls about 10; ornamented by exceedingly fine spiral lines with a prominent, nearly central angulation; base of the shell concave, acutely angulate; mouth subquadrangular; outer lip thin.

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[1] Sign. Cerulli-Irelli, following the Marquis de Gregorio, adopts the varietal name *mediocarinata* for the present form instead of *acutangula*, as he considers the *T. acutangula* of Linné to be a different species.

Dimensions.—L. 20—25 mm. B. 6—8 mm.

Distribution.—Recent: Mediterranean—Nice, coasts of Algeria, Tunis, and Syria.

Fossil: Coralline Crag: Sutton. Waltonian: Little Oakley.

Remarks.—The recent shell here figured is one I received from the Marchese de Monterosato as a typical specimen of his *T. decipiens*, a species now occurring rarely at certain localities in the Mediterranean. It differs from *T. subangulata* and its variety *acutangula* (*mediocarinata*) in its much smaller and more slender form, and in its concave and sharply angulated base. Dr. Carus, who adopts the name *T. decipiens* for the recent shell, considers it equivalent to Brocchi's *T. acutangula*, but the other authorities quoted regard it as specifically distinct, Dr. Gignoux remarking that the one is an Italian Pliocene and extinct shell, the other a recent and much smaller form.

The Coralline Crag specimen figured by Wood as *T. incrassata*, var. *acutangula*, and another I obtained at Oakley, one being 10 mm. and the other 15 mm. in length, may be referred, I think, to the small recent species mentioned, with which they agree more closely than with the much larger and extinct fossil *T. acutangula*. The twisted apex of the recent specimen corresponds with that shown in Wood's figure.

In some respects our shell approaches the *Turbo spiratus* of Brocchi (*op. cit.*, pl. vi, fig. 19), from which it may possibly have descended.

Sub-genus **HAUSTATOR**, Montfort, 1810.

Turritella (Haustator) incrassata (J. Sowerby). Plate XLII, figs. 1—3; 5—7; Plate XLIII, fig. 16.

1814. *Turritella incrassata*, J. Sowerby, Min. Conch., vol. i, p. iii, pl. li, fig. 6.

1842–48. *Turritella incrassata*, S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix. p. 534, 1842; Mon. Crag Moll., pt. i, p. 75, pl. ix, figs. 7 *a*, 7 *c*, 1848.

1843–81. *Turritella triplicata*, Nyst, Coq. foss. Terr. tert. Belg., p. 400, pl. xxxvii, figs. 7, 8, 1843; *T. incrassata*, Conch. Terr. Tert. Belg., p. 82, pl. vi, fig. 12 *c*, 1881.

1871. *Turritella triplicata*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, pp. 146, 492.

1872. *Turritella incrassata*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 204, 210, 214, 216.

1885. *Turritella incrassata*, Lorié, Arch. Mus. Teyler [2], vol. ii, pp. 186, 230 (pt.).

1896. *Turritella incrassata*, Bernays, Bull. Soc. Belge Géol., vol. x (Mémoires), p. 131.

1898–1900. *Turritella incrassata*, F. W. Harmer, Quart. Journ. Geol. Soc., vol. liv, pp. 317, 319, 1898; vol. lvi, pp. 712, 723, 1900.

1912. *Turritella (Haustator) incrassata*, Cossmann, Ess. Paléoconch. compar., vol. ix, p. 118.

1912. *Turritella incrassata*, Tesch, Med. v. d. Rijks. v. Delfstoffen, no. iv, p. 72, no. 163.

1915. *Turritella incrassata*, A. Bell, Geol. Mag. [6], vol. ii, p. 167.

Specific Characters.—Shell large, fairly solid, turreted; whorls generally flattened, or but slightly convex; spire elongate, conical, regularly tapering to an

acute point; ornamented spirally by more or less prominent ridges, varying in number, position, and arrangement but not distinctly and equally triplicate and equidistant as in the type *T. triplicata*, and also by exceedingly fine and thread-like lines; suture slight; base of the shell angulated, flattened, with fine spiral ridges.

Dimensions.—L. 40—65 mm. B. 12—18 mm.

Distribution.—Not recognised living.

Fossil: East Anglian Crag: Coralline to Icenian. Wexford (?).

Miocene, Waenrode bed, Diestien, Casterlien, Scaldisien, Poederlien: Belgium. Casterlien, Scaldisien, Poederlien: Holland.

Remarks.—A difference of opinion has long existed as to the specific identity or otherwise, and consequently as to the correct nomenclature of the shells described respectively by Sowerby as *Turritella incrassata*, and by Brocchi as *Turbo triplicatus*. It seems that Sowerby's name appeared on February 1st, 1814, and Brocchi's during the same year, probably somewhat later. The specific term *incrassata* has been, and is still generally used by Belgian, Dutch, and English writers for the well-known Anglo-Belgian fossil which has not been recognised as a recent form, the term *triplicata* being employed in France and Italy for the shell still existing in southern seas and widely known as fossil in the Miocene, Pliocene, and Pleistocene deposits of extra-British regions. Even if Sowerby's name be the older by a few weeks, I doubt whether foreign Conchologists would now adopt it in lieu of the one they have used for more than a hundred years; but if I am right in thinking the two shells may be regarded as specifically distinct, this will not be necessary and the existing nomenclature may stand. We have both forms, I consider, in the Crag, though *T. incrassata* is the most common. The latter corresponds with Sowerby's shell and is here figured as *T.* (*Haustator*) *incrassata* (Pl. XLII, figs. 1–3; 5—7). The other more nearly agrees with that of Brocchi and is given under his specific name of *triplicata* (figs. 11—14). As to the first named, Sowerby says the whorls are "flattish with the lower part angular and three smooth longitudinal threads"; as to these he says, "two of them are much more prominent than the third"; his figure, which is rather unsatisfactory, shows the ridges to be confined to the lower part of the whorls, the upper part being free from such sculpture. In some of my specimens the third ridge is nearly obsolete.

In Brocchi's figure of *Turbo triplicatus*, on the contrary, and in some fossils I have received from the Miocene deposits of Touraine, the base of the shell is somewhat more rounded, while the three spiral ridges are equally strong, prominent and equidistant.

The typical *T. incrassata* is common in the Coralline, but rather less so in the Red Crag.

Of the three figures of *T. incrassata* given by Nyst in 1881, only one (*op. cit.*, fig. 12 *c*) seems to me (rather doubtfully) characteristic.[1] 12 *a* and 12 *b* are of the

[1] Nyst calls this figure (12 *c*) *T. incrassata*, var. *planispira*. It is not the *T. planispira* of Wood.

triplicata type and are clearly different; as to figs. 12 *d*, 12 *e*, 12 *f*, and 12 *g* they belong, I believe, to more than one other species.

The sub-generic term *Haustator* is now used for a group of large Turritellas, *T. imbricataria* being taken as the type.

Var. **minor**, nov. Plate XLII, figs. 8, 9.

1870. *Turritella incrassata*, S. V. Wood, Jr., and F. W. Harmer, Rep. Brit. Assoc. (Liverpool), Trans. Sect., p. 90.

Remarks.—Fifty years ago the younger Wood and I obtained many specimens of *Turritella incrassata* from the Middle Glacial sands of Billockby, a village about 7 miles W.S.W. of Great Yarmouth; some of them being now in the Wood collection at the Norwich Museum. They were all considerably smaller than the usual Red Crag type, and such shells may be found also in the Icenian Crag of Bramerton. This case seems similar to that of the dwarfed variety of *Potamides tricinctus* from the latter horizon, described above on p. 413.

Turritella (Haustator) triplicata (Brocchi). Plate XLII, figs. 11—14.

1814. *Turbo triplicatus*, Brocchi, Conch. foss. subap., vol. ii, p. 369, pl. vi, fig. 14.

1836–44. *Turritella triplicata*, Philippi, Enum. Moll. Sic., vol. i, p. 190, 1836; vol. ii, p. 160, 1844.

1873–6. *Turritella triplicata*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 356, no. 337, 1873; vol. v, p. 282, no. 123, 1874; vol. vii, p. 100, no. 641, 1876.

1878. *Turritella triplicata*, de Stefani e Pantanelli, Bull. Soc. Malac. Ital., vol. iv, p. 146.

1881. *Turritella incrassata*, Nyst, Conch. Terr. Tert. Belg., p. 82.

1884. *Turritella (Haustator) triplicata*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 227, pl. xxviii, figs. 1—5.

1885. *Turritella incrassata*, Lorié, Arch. Mus. Teyler [2], vol. ii, pp. 186, 230, pl. vii, fig. 5.

1886. *Turritella (Haustator) triplicata*, Dollfus et Dautzenberg, Feuilles des jeunes Nat., vol. xvi, p. 138.

1889–95. *Turritella triplicata*, Sacco, Boll. Soc. Geol. Ital., vol. viii, p. 353, no. 1906, 1889; *Haustator triplicatus* and vars., Moll. Terr. Terz. Piem., pt. xix, p. 26, pl. ii, figs. 32—39, 1895.

1890. *Turritella incrassata*, C. Reid, Plioc. Dep. Brit., p. 260, pl. iii, fig. 3.

1890. *Turritella triplicata*, Carus, Prod. Faun. Medit., vol. ii, p. 354.

1892. *Turritella mediterranea*, Locard, Coq. mar. Côtes de France, p. 125.

1913. *Turritella triplicata*, Gignoux, Ann. Univ. Lyon, n. s. [1], vol. xxxvi, p. 553.

Specific Characters.—Shell strong and solid, resembling *T. incrassata* except that the spiral ridges are more distinctly triplicate and equidistant, the whorls being sometimes more convex, not flattened, while in specimens from the Crag the spire is generally shorter.

Dimensions (of specimens from the Crag).—L. 40—55 mm. B. 13—16 mm.

Distribution.—Recent : Atlantic coasts of Spain, Canary Islands, Mediterranean, Adriatic, Ægean.

Fossil : Red Crag: Little Oakley, otherwise not worked out.

Belgian Crag: Antwerp (Scaldisien ?).

Dutch borings: Utrecht (Scaldisien).

Miocene: Switzerland, France—Anjou, Gironde, Touraine (B. D. D.). Italy—Stazzano, S. Agata.

Lower Pliocene: Biot, Albenga, Siena.

Upper Pliocene (Astiano): Monte Mario, Messina.

Pleistocene: Italy—Reggio, Monteleone, Taranto, Gravina, San Giovanni, Livorno. Sicily—Messina, Monte Pellegrino.

Remarks.—This form, well represented by Mr. C. Reid's figure of *T. incrassata*, in his Pliocene Deposits of Britain (pl. iii, fig. 3), occurs at Oakley. So far as my experience goes, it is a Red rather than a Coralline Crag species. Dr. Lorié's figure of *T. incrassata* (*op. cit.*, pl. vii, fig. 5) from the Scaldisien of the Utrecht boring, seems also to be of the same type. The difference between this shell and *T. incrassata*, is mainly one of sculpture, which in the typical *T. triplicata* is more regular and much stronger, approaching more nearly that of *T. vermicularis*, next to be described, and the suture is generally deeper. Some persons might prefer to regard the three forms as varieties of one species, but which is to be the type? As stated above, I doubt very much whether continental authorities would adopt *T. incrassata*, which it seems is probably slightly the oldest name. It will be more convenient, I think, to "let sleeping dogs lie" and consider these allied forms as specifically distinct. Some other of the Crag Turritellas, moreover, the difference between which is principally one of sculpture, have a zonal value.

Turritella (Haustator) vermicularis (Brocchi). Plate XLII, fig. 10; Plate XLIII, figs. 1—3.

1814. *Turbo vermicularis*, Brocchi, Conch. foss. subap., vol. ii, p. 372, pl. vi, fig. 13.

1848. *Turritella incrassata*, var. β (*vermicularis*), S. V. Wood, Mon. Crag Moll., pt. i, p. 75, pl. vi, fig. 7*b*.

1856. *Turritella vermicularis*, Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 422, pl. xliii, figs. 17, 18.

1876. *Turritella vermicularis*, Seguenza, Boll. R. Com. Geol. Ital., vol. vii, p. 100, no. 640.

1881. *Turritella incrassata* (pt.), Nyst, Conch. Terr. Tert. Belg., p. 82, pl. vi, fig. 12*a* (?).

1889–95. *Turritella vermicularis*, and vars., Sacco, Boll. Soc. Geol. Ital., vol. viii, p. 353, no. 1909, 1889; *Haustator vermicularis*, and vars., Moll. Terr. Terz. Piem., pt. xix. pp. 21—24, pl. ii, figs. 10–24, 1895.

1912. *Turritella* (*Haustator*) *vermicularis*, Cossmann, Ess. Paléoconch. compar., vol. ix, p. 115, pl. vii, figs. 10, 11.

1912. *Turritella* (*Haustator*) *vermicularis*, Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 163, pl. xxv, figs. 1–6.

1913. *Turritella* (*Haustator*) *vermicularis*, Gignoux, Ann. Univ. Lyon, n.s. [1], p. 554.

Specific Characters.—Shell large, strong, subulate, turreted; whorls 14 or 15, convex, coarsely ornamented (in the type) by 3 or 4 prominent spiral ribs, more or less equidistant, continuous to the base of the shell, with deep furrows between, the intervening spaces being finely striated; suture deep and excavated; base rounded; spire elongate, regularly diminishing in size.

Dimensions.—L. 70—90 mm. B. 18—20 mm.

Distribution.—Not known living.

Fossil: Waltonian: Walton-on-Naze, Beaumont, Little Oakley.

Scaldisien: Antwerp.

Miocene: Vienna basin, northern Italy, Tuscany.

Lower Pliocene: northern Italy.

Upper Pliocene: Ligurian coast, Bologna, Monte Mario, Asti, Livorno, Orciano, Caltabiano.

Remarks.—This species, which is said by Prof. Sacco to be abundant at many localities in the Piacenziano of Piedmont, is especially and exceedingly so in the Upper Pliocene of Asti, where I obtained a number of specimens of it, occurring elsewhere not infrequently in the Pliocene and Miocene deposits of Italy.

It is a large, strong, coarsely sculptured shell, which, although variable within certain limits, has generally a distinctive character of its own. Specimens from the Miocene of the Vienna basin, figured by Hörnes under the present name have three strong, equal and equidistant ridges. In the Italian fossils the ridges are usually four, but the variety *lineolato-cincta*, Sacco, has five or six.

I have found several imperfect specimens at Oakley, more or less nearly corresponding with the typical *T. vermicularis* of Asti, or the variety of it just named. They appear to be derivative, but as this species is widely distributed in the Upper Pliocene of southern Europe it may possibly have lived on in the Anglo-Belgian basin until the commencement of the Red Crag period.

MM. Bucquoy and his colleagues regard *T. vermicularis* as a variety of *T. triplicata,* as do Sign. Cerulli-Irelli, and S. V. Wood,[1] while M. Cossmann seems to consider them distinct. As before remarked, these two forms seem more nearly related than do the typical Crag forms of *T. triplicata* and *T. incrassata*—in fact, some of my Oakley specimens grouped as *T. vermicularis* might almost be regarded as intermediate between the latter and *T. triplicata*; as a rule, however, they tend rather to vary in the direction of the many-ridged variety *lineolato-cincta*.

Var. **lineolato-cincta** (Sacco). Plate XLIII, figs. 4—6.

1895. *Turritella* (*Haustator*) *vermicularis*, var. *lineolato-cincta*, Sacco, Moll. Terr. Terz. Piem., pt. xix, p. 23, pl. ii, fig. 17.

1912. *Turritella* (*Haustator*) *vermicularis*, var. *lineato-cincta*, Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 164, pl. xxv, fig. 5.

[1] Wood's coarsely and strongly triplicate specimen (*op. cit.*, pl. ix, fig. 7*b*) figured as *T. incrassata*, var. *β. vermicularis*, seems of the *T. vermicularis* type.

Varietal Characters.—Agrees with the type in size, in its convex whorls, deep suture and coarse sculpture, but differs from it in the greater number of its spiral ridges.

Dimensions.—L. 65—75 mm. B. 18—20 mm.

Distribution.—Not known living.

Fossil: Waltonian Crag: Walton-on-Naze, Little Oakley.

Miocene, Pliocene, Upper and Lower (abundant): Italy.

Remarks.—One of the imperfect Crag fossils here figured is from Walton, the other from Oakley, where I have found several others, also imperfect. I figure with them a perfect specimen from Asti. Prof. Sacco reports this variety also from the Lower Pliocene of Albenga and Bordighera, where, he says, it is abundant, and from the Miocene (Elveziano) of Turin, where it is rare.

Turritella (Haustator) erthensis, sp. nov. Plate XLII, fig. 4.

1885. *Turritella triplicata,* S. V. Wood, Quart. Journ. Geol. Soc., vol. xli, p. 65.
1886. *Turritella triplicata,* Kendall and R. Bell, Quart. Journ. Geol. Soc., vol. xlii, p. 211.
1898. *Turritella triplicata,* A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, pp. 128, 149.

Specific Characters.—Shell large, elongate, with an expanded base; whorls about 15, enlarged and ridged below, convex above, the last one-fourth the total length, the base of each whorl projecting slightly beyond the one next below it; spire acutely conical, regularly diminishing in size; suture conspicuous; ornamented by three prominent, clearly chiselled ridges, the lowest just above the suture, the second placed closer to it than to the third, the three occupying rather less than half the width of the whorls, the upper or concave part of which is covered with fine irregular thread-like lines; base rounded, obtusely angulate, finely and spirally ridged.

Dimensions.—L. 60—70 mm. B. 18 mm.

Distribution.—Not known living.

Fossil: St. Erth.

Remarks.—As already stated, a number of the large Turritellas of the Anglo-Belgian basin have been regarded, under the influence of views formerly prevailing, to be varieties of the *T. incrassata* of Sowerby or of its supposed equivalent, the *Turbo triplicatus* of Brocchi. It is true that many of them agree generally in form, but they differ in sculpture. It is on the latter feature, therefore, we must chiefly depend for the identification of our fossils. Guided by this principle, it will be seen, I think, that several of the Crag Turritellas hitherto regarded as varietal, may be either associated with certain species believed by foreign authorities to be specifically distinct, or may be considered as forms hitherto unrecorded from our deposits which deserve recognition. The present fossil belongs, I think, to the

latter group. It has been described by those who have written on the subject as identical with *T. triplicata*, but the sculpture as well as the form of these two is essentially different, and they do not appear to have any near relationship. It is equally difficult, I suggest, to regard our shell as a variety of *T. incrassata*. It occurs only, but very abundantly at St. Erth, and many specimens of it are to be found in our public collections, as, for example, in the Sedgwick Museum at Cambridge. They are all of the same type, agreeing with each other, but, so far as I know, with nothing else that has been hitherto described. It may be desirable, therefore, I think, to consider them specifically distinct.

Turritella (Haustator) crenulata (Nyst). Plate XLII, figs. 18, 19.

1843. *Turritella crenulata*, Nyst, Coq. foss. Terr. tert. Belg., p. 399, pl. xxxvii, fig. 6.
1874. *Turritella crenulata*, Van den Broeck, Ann. Soc. Roy. Malac. Belg., vol. ix, p. 157.
1912. *Turritella (Haustator) crenulata*, Cossmann, Ess. Paléoconch. compar., vol. ix, p. 118.

Specific Characters.—Shell of moderate size, elongate, turreted; whorls convex; suture deep; ornamented by 6 or 7 spiral ridges, equal and equidistant; base rounded.

Dimensions.—L. 20—25 mm. B. 5—6 mm.

Distribution.—Not known living.

Fossil: Waltonian Crag: Little Oakley.

Oligocene: Belgium—Vliermael, Hoesselt, Bolderberg.

Pliocene (Diestien): Belgium.

Remarks.—I have one or two imperfect specimens in my collection from Oakley which appear to correspond with some specimens of *T. crenulata*, Nyst, in the Sedgwick Museum, received some years ago under that name from the Royal Museum of Natural History at Brussels, of which Nyst was then the Director. They do not altogether correspond with the specimen given by the latter in 1843, but my experience of the last few years has shown me that the pre-photographic figures of the earlier writers are not always to be relied on. Our shell may be probably derivative in the Crag.

Turritella (Haustator) marginalis (Brocchi). Plate XLIII, figs. 9—11.

1814. *Turbo marginalis*, Brocchi, Conch. foss. subap., vol. ii, p. 373, pl. vi, fig. 20.
1832–40. *Turritella marginalis*, Grateloup, Actes Soc. Linn. Bordeaux, vol. v, p. 165, no. 245, 1832; Atlas (Turritella), pl. i, fig. 11, 1840.
(?) 1856. *Turritella marginalis*, Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 428, pl. xliii, fig. 4.
1882. *Turritella marginalis*, von Koenen, Nord-deutsch. Miocän, Moll.-faun., vol. ii, p. 286, no. 191.
1886. *Turritella (Haustator) marginalis*, Dollfus et Dautzenberg, Feuilles des jeunes Nat., vol. xvi, p. 138.
1890–5. *Turritella marginalis* and vars., Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 324, no. 5319, 1890; *Haustator marginalis*, Moll. Terr. Terz. Piem., pt. xix, p. 16, pl. i, fig. 55, 1895.

Specific Characters.—Shell strong and solid, subulate, turreted; whorls nearly flat, regularly diminishing in size; ornamented by fine spiral striations, generally with a ridge near the suture; spire slender, elongate; suture distinct, sometimes channelled; base angulated.

Dimensions.—L. 50 mm. B. 18 mm.

Distribution.—Not known living.

Fossil: Waltonian Crag: Little Oakley. Newbournian: Bentley.

Miocene: France, north Germany, Vienna basin, Italy.

Lower and Upper Pliocene: Piedmont, Liguria.

Remarks.—One of the Crag fossils from Oakley figured under this name agrees fairly well with a specimen of *T. marginalis* which I have received from Touraine, although the identification can hardly be regarded as conclusive, but as I have several others of the same kind it seems desirable to figure with it a verified and perfect specimen of this species for comparison with any future finds. The fossil from Bentley (fig. 10) is more slender, but it closely resembles the one taken as the type by Hörnes from the Miocene of the Vienna basin (*op. cit.*). The latter approaches the *T. planispira* of Wood, but the sculpture is different.

T. marginalis is recorded from the Miocene deposits of various parts of Europe and by Prof. Sacco from the Upper and Lower Pliocene of northern Italy. It may be derivative in the Crag.[1]

Turritella (Haustator) planispira (S. V. Wood). Plate XLIV, fig. 16.

1842–72. *Turritella planispira*, S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix, p. 534, 1842; Mon. Crag Moll., pt. i, p. 76, pl. ix. fig. 11, 1848; 1st Suppl., pt. i, p. 54, 1872.

1843. *Turritella planispira*, Nyst, Coq. foss. Terr. tert. Belg., p. 401, pl. xxxviii, fig. 9.

1871. *Turritella subangulata*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 146.

1872. *Turritella planispira*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 204.

1898. *Turritella planispira*, A. Bell, Trans. Roy. Geol. Soc. Cornwall, vol. xii, p. 149.

Specific Characters.—Shell slender, rather small, subulate; whorls flat or nearly so; spire forming an elongated cone; suture slight; ornamented by fine angular and equidistant ridges; base of the shell angulated.

Dimensions.—L. 35 mm. B. 10 mm.

Distribution.—Not known living.

Fossil: St. Erth (A. Bell). Coralline Crag: Sutton. Waltonian: Walton-on-Naze, Beaumont, Little Oakley. Newbournian: Newbourn, Sutton.

Remarks.—I have a fair number of specimens, more or less imperfect, from Oakley, which seem to be the *T. planispira* of Wood. They belong to the same group as the larger and more finely sculptured form described above, though with

[1] The figures of *T. marginalis* given by Brocchi and Sacco have a more distinctly channelled suture than that of Hörnes. Our Crag shells more nearly resemble the latter.

some doubt, as the *T. marginalis* of Brocchi and of Hörnes, agreeing with the *T. planispira* of Nyst's work of 1843 (*op. cit.*), but not with the Scaldisien fossil figured by him in 1881 as *T. incrassata*, var. *planispira*, which is, I consider, a different species.[1]

Turritella (Haustator) imbricataria (Lamarck). Plate XLIII, figs. 12—14.

1804. *Turritella imbricataria*, Lamarck, Ann. du Mus., vol. iv, p. 216, pl. xxxvii, fig. 7.
1812. *Turritella conoidea*, Sowerby, Min. Conch., vol. i, p. 109, pl. li, fig. 5.
1824. *Turritella imbricataria* and vars., Deshayes, Desc. Coq. foss. Env. de Paris, vol. ii, p. 271, pl. xxxv, figs. 1, 2; pl. xxxvi, figs. 7, 8; pl. xxxvii, figs. 9, 10.
1842–48. *Turritella conoidea*, S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix, p. 534, 1842; *T. imbricataria*, Mon. Crag Moll., pt. i, p. 75, pl. ix, fig. 10, 1848.
1843. *Turritella imbricataria*, Philippi, Beitr. Kennt. Tert. Deutsch., pp. 56, 75.
1843–81. *Turritella imbricataria*, var. β, Nyst, Coq. foss. Terr. tert. Belg., p. 396, pl. xxxvii, fig. 5, 1843; *T. incrassata*, var. *imbricataria*, Conch. Terr. Tert. Belg., p. 83, pl. vi, fig. 12 *f*, 1881.
1891. *Turritella imbricataria*, Harris and Burrows, Eoc. and Oligoc. Paris basin, p. 87.
1912. *Turritella (Haustator) imbricataria*, Cossmann, Ess. Paléoconch. compar., vol. ix, p. 114, pl. viii, figs. 10, 11.

Specific Characters.—Shell subulate, turreted, with an elongated spire, ending in a fine, but twisted, apex; whorls flattened, compressed above, expanded and subangulated below, so as to project beyond those following; suture oblique, deep, with the base of the whorl forming a step to the one above it; ornamented with inconspicuous spiral ridges extending to the base of the shell.

Dimensions.—L. 55 mm. B. 12 mm.

Distribution.—Not known living.

Fossil: Eocene: Hampshire basin, France, Germany, Belgium. Red Crag (derivative).

Remarks.—Worn examples, often imperfect, of this shell, characteristic of the Middle Eocene of Belgium, France and the Hampshire basin, are not infrequently found in the Red Crag. They are unknown from the Coralline horizon, generally differing in colour from the typical Red Crag fossils, and are no doubt derivative in the latter, having come apparently from some older fossiliferous Tertiary deposits once existing, but not now known, in or near the Crag region. I have found a few fragmentary specimens at Oakley, but most of those in our public collections have been obtained from the Newbournian beds of Waldringfield, where some other fossils, also thought to be derivative, are not uncommon.

The *Turbo imbricatarius* of Brocchi, an Italian species from the Lower Pliocene, seems to be different both from Lamarck's Eocene shell, and from those of our Crag deposits.

[1] Conch. Terr. Tert. Belg., pl. vi, fig. 12 *c*.

Turritella (Haustator) tornata (Brocchi). Plate XLIII, figs. 7, 8.

1814. *Turbo tornatus,* Brocchi, Conch. foss. subap., vol. ii, p. 372, pl. vi, fig. 11.
1870. *Turritella tornata,* A. Bell, Journ. de Conch., vol. xviii, p. 350, no. 354.
1873–6. *Turritella tornata,* Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 356, no. 339, 1873; vol. v, p. 158, no. 124, 1874; vol. vii, p. 100, no. 639, 1876.
1878. *Turritella tornata,* de Stefani e Pantanelli, Bull. Soc. Malac. Ital., vol. iv, p. 147.
1889–95. *Turritella tornata,* Sacco, Boll. Soc. Geol. Ital., vol. viii, p. 353, no. 1908, 1889; vol. ix, p. 324, no. 5317, 1890; *Haustator tornatus,* Moll. Terr. Terz. Piem., pt. xix, p. 24, pl. ii, fig. 25, 1895.
1912. *Turritella (Haustator) tornata,* Cossmann, Ess. Paléoconch. compar., vol. ix, p. 119.
1912. *Turritella (Haustator) tornata,* Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 164, pl. xxv, figs. 7—17.
1913. *Turritella (Haustator) tornata,* Gignoux, Ann. Univ. Lyon, n.s. [1], vol. xxxvi, p. 554.

Specific Characters. — Shell large, strong, subulate; whorls nearly flat, regularly diminishing in size upwards; coarsely ornamented by rather fine, rounded spiral ridges, varying in number and thickness; spire slender, elongate; suture slight; base angular.

Dimensions.—L. 80—100 mm. B. 15—25 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Sutton. Waltonian: Little Oakley. Newbournian: Waldringfield.

Miocene: northern Italy (Elveziano).

Lower Pliocene: northern Italy, many localities, abundant in places. Biot.

Upper Pliocene: Asti, Bologna, Monte Mario, Legoli, Siena, Caltabiano.

Pleistocene: Valle Biaia. Monte Pellegrino. Naso, Barcellona-Castroreale.

Remarks.—*Turritella tornata* is a characteristic species of the Italian Pliocene; it was in existence in southern seas in Miocene times, where it lingered on to the Pleistocene period. The Crag fossil here figured belongs to the Ipswich Museum, and was obtained from the Coralline Crag of Sutton. I have some imperfect specimens of it from Oakley and there is another from Waldringfield in Major Moore's collection which seems to be the same, though larger in size—25 mm. in breadth.

Turritella (Haustator) biplicata (Bronn). Plate XLIII, figs. 17, 18.

1831. *Turritella (Turbo) biplicata,* Bronn, Ital. Tert. Gebild., p. 53.
1881. *Turritella incrassata,* var. *bicincta,* Nyst, Conch. Terr. Tert. Belg., p. 82, pl. vi, fig. 12 *g.*
1889–95. *Turritella biplicata,* Sacco, Boll. Soc. Geol. Ital., vol. viii, p. 353, no. 1907, 1889; *Haustator biplicatus,* Moll. Terr. Terz. Piem., pt. xix, p. 21, 1895.
1912. *Turritella (Haustator) biplicata,* Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 161, pl. xxiv, figs. 40—45.
1912. *Turritella (Haustator) biplicata,* Cossmann, Ess. Paléoconch. compar., vol. ix, p. 119.

Specific Characters.—Shell solid, turriculate; whorls nearly flat, depressed above, the base of the last distinctly angulate, the upper ones projecting a little

beyond those below them; suture slight but channelled; ornamented by two flattened spiral ridges, plicate rather than carinate, the lower one rather the more prominent, and by exceedingly fine spiral lines.

Dimensions.—L. 45—50 mm. B. 12—14 mm.

Distribution.—Not known living.

Fossil: Waltonian Crag: Little Oakley.

Lower Pliocene (Piacenziano): northern Italy.

Upper Pliocene (Astigiano): Monte Mario.

Remarks.—The fossils represented under the above name, of which I have obtained several examples from Oakley, correspond very closely with those figured by Sign. Cerulli-Irelli from Monte Mario, where he says they are not rare. They seem to separate themselves by their special spiral sculpture from the rest of the many Turritellas I have obtained from Oakley, most of which may be referred to *T.* (*Haustator*) *triplicata* or *T.* (*Haustator*) *incrassata*, forms which, as stated above, I regard as specifically distinct. They differ from the Miocene shell *T. bicarinata*, described below, in that their spiral ridges are flattened, the lower one being the more prominent, besides which the latter species is regarded by Prof. Sacco and M. Cossmann as belonging to a different sub-genus, *Archimediella.*

The specimen from the Scaldisien of Antwerp figured by Nyst in 1881 as *T. incrassata*, var. *bicincta* (*op. cit.*), may be probably the present form. The var. γ, *bicincta* of Wood (Mon. Crag Moll., pt. i, pl. ix, fig. 7 *d*, 1848) is a different shell (see p. 439 of the present work).

It may be again noticed that many specimens of the Crag Turritellas which we have been accustomed to regard as varieties of *T. incrassata*, seem rather to group themselves with certain Pliocene or Miocene forms which continental Conchologists have regarded as specifically or even as sub-generically distinct.

Sub-genus **ARCHIMEDIELLA,** Sacco, 1895.

Turritella (Archimediella) bicarinata (Eichwald). Plate XLIII, figs. 19, 20.

1830. *Turritella bicarinata*, Eichwald, Naturhist Skizze v. Lithauen u. Volhynien, p. 220.
1856. *Turritella bicarinata*, Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 426, pl. xliii, figs. 8—12
1876. *Turritella bicarinata*, Seguenza, Boll. R. Com. Geol. Ital., vol. vii, p. 100, no. 638.
1882. *Turritella Archimedis*, von Koenen, Nord-deutsch. Miocän Moll.-fauna, vol. ii, p. 285, no. 190.
1886. *Turritella bicarinata*, Dollfus et Dautzenberg, Feuilles des jeunes Nat., vol. xvi, p. 138.
1889–95. *Turritella bicarinata* and vars., Sacco, Boll. Soc. Geol. Ital., vol. viii, p. 352, no. 1890, 1889; *Archimediella bicarinata* and vars., Moll. Terr. Terz. Piem., pt. xix, p. 14, pl. i, figs. 48—52, 1895.
1903. *Turritella bicarinata*, Dollfus, Cotter et Gomes, Moll. Tert. Portugal, p. 4, pl. xxx, fig. 4.
1907. *Turritella Archimedis*, Ravn, Kongl. Danske Vid. Selsk. Skrift., vol. vii, p. 296, pl. iii, fig. 15.
1912. *Turritella* (*Archimediella*) *bicarinata*, Cossmann, Ess. Paléoconch. compar., vol. ix, p. 122, pl. vi, figs. 29, 30.

Specific Characters.—Shell turreted, strong and solid; whorls but slightly convex, excavated and somewhat concave above; ornamented by two sharp, prominent spiral ridges, the lower one just above the suture forming a keel to the whorls, the other being central, and by exceedingly fine thread-like lines; spire elongate but comparatively short, regularly diminishing in size, with a blunt and twisted apex; suture slight.

Dimensions.—L. 35—45 mm. B. 14 mm.

Distribution.—Not known living.

Fossil: Waltonian Crag: Little Oakley.

Miocene: Denmark, Touraine, Vienna basin, Italy.

Lower Pliocene: Portugal (Lower Helvetian). Italy—Castellarquato.

Upper Pliocene: Tuscany, Val d'Era.

Remarks.—The Crag specimen figured under this name is from Oakley; it corresponds with some I obtained from the Faluns of Touraine. It is in very fresh condition, nearly perfect, showing clearly the fine, characteristic spiral sculpture of this species, and does not present the appearance of being derivative, but as it occurs in the Upper Miocene of Denmark, and possibly in that of North Germany, it may be so. On the other hand, it is found in the Upper Pliocene of Tuscany, and is perhaps one of those many Miocene species that lingered on in the Anglo-Belgian basin until Waltonian-Scaldisien times. Our knowledge of the Miocene fauna of Belgium is unfortunately very imperfect.

By some authorities *T. bicarinata* is identified with *T. Archimedis*, but Hörnes considered them distinct. His figures show the latter to have a longer spire. In our Crag fossil the spire is comparatively short, corresponding most nearly with the shell given by Dr. Ravn under the latter name from the Upper Miocene of Esbjerg.

The sub-genus *Archimediella* was proposed by Prof. Sacco for a group of the Turritellidæ specially characterised by having two prominent spiral ridges.

Genus **VERMETUS,** Adanson, 1757.

Sub-genus **PETALOCONCHA,** Lea, 1845.

Vermetus (Petaloconcha) intortus (Lamarck). Plate XLIV, figs. 33, 34.

1818. *Serpula intorta,* Lamarck, Hist. Nat. Anim. sans Vert., vol. v, p. 365, no. 889.

1844. *Vermetus intortus,* Philippi, Enum. Moll. Sic., vol. ii, p. 144.

1842–8. *Vermetus intortus,* S. V. Wood, Ann. Mag. Nat. Hist. [1], vol. ix, p. 532, 1842; Mon. Crag Moll., pt. i, p. 113, pl. xii, fig. 8 *a*, 1848.

1856. *Vermetus intortus,* Hörnes, Foss. Moll. Tert. Wien, vol. i, p. 484, pl. xlvi, fig. 16.

1870. *Vermetus intortus,* A. Bell, Journ. de Conch., vol. xviii, p. 350, no. 359.

1871. *Vermetus subcancellatus*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, pp. 146, 492.
1872. *Vermetus intortus*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 204.
1873–6. *Vermetus intortus*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 356, no. 346, 1873; vol. v, p. 282, no. 126, 1874; vol. vii, p. 100, no. 649, 1876.
1878. *Vermetus intortus*, de Stefani e Pantanelli, Bull. Soc. Malac. Ital., vol. iv, p. 144.
1881. *Vermetus intortus*, Nyst, Conch. Terr. Tert. Belg., p. 84, pl. vi, figs, 13 *a*, 13 *c*.
1881. *Vermetus intortus*, Fontannes, Moll. plioc. Vall. du Rhone., vol. i, p. 201, pl. xi, fig. 6.
1884. *Vermetus* (*Serpulus*) *intortus*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 235, pl. xxx, figs. 15, 16.
1889–96. *Vermetus intortus*, Sacco, Boll. Soc. Geol. Ital., vol. viii, p. 353, no. 1911, 1889; *V.* (*Petaloconchus*) *intortus*, Moll. Terr. Terz. Piem., pt. xx, p. 7, pl. i, fig. 12, 1896.
1892. *Vermetus intortus*, Van den Broeck, Bull. Soc. Belge Géol., vol. vi (Mémoires), pp. 123, 147.
1896. *Vermetus intortus*, Bernays, Bull. Soc. Belge Géol., vol. x (Mémoires), p. 129.
1912. *Vermetus* (*Petaloconcha*) *intortus*, Cossmann, Ess. Paléoconch. compar., vol. ix, p. 135, pl. x, figs. 20, 21.
1912. *Vermetus intortus*, Tesch, Med. v. d. Rijks. v. Delfstoffen, no. iv, p. 72, no. 166.
1912. *Vermetus* (*Petaloconchus*) *intortus*, Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 155, pl. xxiii, figs. 80—84.

Specific Characters.—Shell fairly thick and strong, tubular, the tubes being subquadrangular, closely rolled upon themselves so as to form a subcylindrical, spiral coil with a very narrow suture, or subglomerate; ornamented by irregular rugose ridges, spiral and transverse; mouth subcircular.

Dimensions.—Size of coil irregular; diameter of tube, 5 mm.; of coil, 10 mm.

Distribution.—Not known living.

Fossil: Coralline Crag: Sutton, Ramsholt. Waltonian: Walton-on-Naze, Beaumont, Little Oakley. Casterlien: Belgium. Scaldisien: Holland, Belgium.

Miocene: Vienna basin, northern Italy, Touraine.

Lower Pliocene: Biot, Ligurian coast (abundant in places), Piedmont, Tuscany, south-west France.

Upper Pliocene: Italy—Piedmont, Asti, Bologna, Monte Mario, Val d'Era, Corace. Sicily—Altavilla, Caltabiano.

Pleistocene: Italy—Gravina. Sicily—Palermo, Nizzeti, Militello.

Remarks.—There seems some difference of opinion as to whether *V. intortus* should be regarded as still living, but this may be due to its having been identified by some Conchologists with another Mediterranean species; Messrs. Dautzenberg and Dollfus consider it an extinct form, giving their reasons for doing so,[1] and Sign. Cerulli-Irelli has expressed a similar opinion.[2] It is a characteristic Pliocene fossil, very common, according to Prof. Sacco, at certain Pliocene localities in northern Italy. I have figured a typical specimen from the Lower Pliocene *argiles*

[1] *Op. cit.*, vol. i, p. 235.
[2] *Op. cit.*, vol. xviii, p. 155.

bleues of Bordighera,[1] together with one from Oakley with which it seems to correspond.

Imperfect specimens of *Vermetus* are not very rare at Oakley, but most of them belong to the smaller species, *V. glomeratus*, next to be described. One of Wood's fossils (pl. xii, fig. 8 *b*) is probably of that form; it is not a typical example of *V. intortus*.

The tubes of *V. intortus* are squarely angulated and not round. Some specimens of *Vermetus* which I found at Antwerp seem to belong to this species, as do those figured by Nyst (*op. cit.*) under the present name.

Vermetus (Petaloconcha) glomeratus (Linné). Plate XLIV, figs. 29—32.

1758. *Serpula glomerata,* Linné, Syst. Nat., ed. x, p. 787, no. 694.

1836–44. *Vermetus subcancellatus,* Philippi, Enum. Moll. Sic., vol. i, p. 172, pl. ix, fig. 20, 1836; vol. ii, p. 144, 1844.

1848. *Vermetus intortus* (pt.), S. V. Wood, Mon. Crag Moll., pt. i, p. 113, pl. xii, fig. 8 *b*.

1870–1. *Vermetus subcancellatus.* A. Bell, Journ. de Conch., vol. xviii, p. 350, no. 360, 1870; *V. glomeratus,* Ann. Mag. Nat. Hist. [4], vol. vii, p. 359, 1871.

1871. *Vermetus glomeratus,* Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 492.

1872. *Vermetus subcancellatus,* A. and R. Bell, Proc. Geol. Assoc., vol. ii, pp. 204, 210, 214.

1873. *Vermetus subcancellatus,* Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 356, no. 345, 1873; vol. vii, p. 100, no. 646, 1876.

1884. *Vermetus glomeratus,* Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 234, pl. xxx, figs. 11—14.

1890. *Vermetus glomeratus,* Carus, Prod. Faun. Medit., vol. ii, p. 356.

1890–96. *Vermetus subcancellatus,* Sacco, Boll. Soc. Geol. Ital., vol. ix, p. 325, no. 5325, 1890; *V. glomeratus,* Moll. Terr. Terz. Piem., vol. xx, p. 6, 1896.

1912. *Vermetus* (*Petaloconchus*) *glomeratus,* var., Cerulli-Irelli, Palaeont. Ital., vol. xviii, p. 155, pl. xxiii, figs. 85, 86.

1912. *Vermetus* (*Petaloconcha*) *glomeratus,* Cossmann, Ess. Paléoconch. compar., vol. ix, p. 136.

Specific Characters.—Shell tubular; the tubes not being angulated but round, and smaller than in *V. intortus*, disjoined, irregularly ornamented by transverse and longitudinal ridges, sometimes wound upon themselves in the shape of narrow, continuous, subcylindrical and spiral coils, at others forming agglomerated and confused masses, occasionally of considerable size, without any definite shape or arrangement; mouth circular; peristome continuous.

Dimensions.—Diameter of tube, 2—3 mm.

Distribution.—*Recent:* Mediterranean and Adriatic, littoral zone.

Fossil: Coralline Crag: Sutton, Ramsholt. Waltonian: Walton-on-Naze, Beaumont, Little Oakley. Newbournian: Sutton, Waldringfield, Bromswell.

[1] I have just heard from my friend Mr. Clarence Bicknell, of Bordighera, that the interesting sections at that place which formerly yielded so many fossils are now covered with buildings, terraces or gardens.

Miocene: Italy (Tortoniano).

Lower Pliocene: Biot, Liguria, Siena.

Upper Pliocene: Liguria, Piedmont, Monte Mario, Bologna, Val d'Era, Altavilla.

Pleistocene: Messina, San Giovanni, Nizzeti, Taranto.

Remarks.—MM. Bucquoy, Dautzenberg and Dollfus state (*op. cit.*, p. 234) that it has been now definitely ascertained that the *Serpula glomerata* of Linné is the species afterwards described by Bivona as *Vermetus subcancellatus*, and that the *V. glomeratus* of the latter is a different shell. If this is so, the name of the fossils hitherto known to Crag geologists as *V. subcancellatus* should be changed. They are fairly common at Oakley from which place I have 50 or 60 specimens in my collection, most of them, however, being more or less fragmentary. Some of them are in the form of a simple spiral coil, others are amorphous agglomerations of the coiled tubes, growing on each other without any plan or arrangement. Wood says that one of the masses in his collection was nearly as large as a hen's egg. The figures of *V. glomeratus* in the work on the Mollusca of Rousillon agree very well with my Oakley fossils.

Sub-genus **BIVONIA**, Gray, 1842.

Vermetus (Bivonia) triqueter (Bivona). Plate XLIV, figs. 24—28.

1832. *Vermetus triqueter*, Bivona, Nuov. Gen. e Spec. di Moll., p. 11, pl. ii, fig. 4.

1836–44. *Vermetus triqueter* (pt.), Philippi, Enum. Moll. Sic., vol. i, p. 170, pl. ix, fig. 21, 1836; vol. ii, p. 143, 1844.

1870–1. *Vermetus triqueter*, A. Bell, Journ. de Conch., vol. xviii, p. 357, no. 362, 1870; Ann. Mag. Nat. Hist. [4], vol. vii, p. 359, 1871.

1871. *Vermetus triqueter*, Jeffreys in Prestwich, Quart. Journ. Geol. Soc., vol. xxvii, p. 492.

1872. *Vermetus triqueter*, A. and R. Bell, Proc. Geol. Assoc., vol. ii, p. 210.

1873. *Vermetus triqueter*, Seguenza, Boll. R. Com. Geol. Ital., vol. iv, p. 356, no. 343.

1878. *Vermetus triqueter*, de Stefani e Pantanelli, Bull. Soc. Malac. Ital., vol. iv, p. 144.

1884. *Vermetus (Dofania) triqueter*, Bucquoy, Dautzenberg et Dollfus, Moll. mar. Rouss., vol. i, p. 238, pl. xxx, figs. 1—6.

1884. *Dofania (?) triquetra*, Monterosato, Nom. Gen. e Spec. Conch. Medit., p. 82.

1890. *Vermetus triqueter*, Carus, Prod. Faun. Medit., vol. ii, p. 356.

1892. *Vermetus triqueter*, Locard, Coq. mar. Côtes de France, p. 132.

1896. *Vermetus (Bivonia) triquetra*, Sacco, Moll. Terr. Terz. Piem., pt. xx, p. 13, pl. ii, figs. 1—8.

1912. *Vermetus (Bivonia) triqueter*, Cossmann, Ess. Paléoconch. compar., vol. ix, p. 136, pl. x, fig. 4.

Specific Characters.—Shell tubular, coiled upon itself, the coils often adherent to stones; flattened on the fixed side, strongly ridged above, giving the tubes a triangulate appearance; ornamented by numerous fine and irregular plications; mouth subcircular.

Dimensions.—Diameter of tube, 5—6 mm.

Distribution.—*Recent:* Mediterranean, Adriatic.

Fossil: Waltonian Crag: Little Oakley (fragments). Newbournian: Waldringfield (Bell), Foxhall (Jeffreys). Wexford.

Miocene: Touraine.

Lower Pliocene: Biot, Savona, Ceriale, Siena.

Upper Pliocene: Asti.

Pleistocene: Messina, Monte Pellegrino, Taranto, Catania.

Remarks.—This Mediterranean shell has been reported by Jeffreys and Mr. A. Bell from the Newbournian Crag; I have several specimens from Oakley and another from Wexford, which, though fragmentary, are not too much so for identification. The more nearly perfect one here figured I obtained many years ago from the Sicilian Pleistocene of Ficarazzi, near Palermo. *V. triqueter* is a distinct form, easily recognised. The Oakley fossils here figured, though worn, show the central ridge, and to some extent the characteristic transverse plications of the species in question. Dr. Scalia records this species from the sub-Etnaen deposits of Catania.

Sub-genus **BURTINELLA**, Mörch, 1861.

Vermetus (Burtinella) bognoriensis (Mantell). Plate XLIV, fig. 23.

1822–50. *Vermicularis Bognoriensis*, Mantell, Geol. Sussex, pp. 272, 307; Atlas, p. 135, pl. lviii, figs. 8, 9, 1850.
1829. *Vermetus Bognoriensis*, J. Sowerby, Min. Conch., vol. vi, p. 194, pl. dxcvi, figs. 1, 2, 3.
1833. *Serpula*, sp., Parkinson, Organ. Remains, vol. iii, p. 92, pl. vii, fig. 8.
1848. *Vermetus Bognoriensis*, S. V. Wood, Mon. Crag Moll., pt. i, p. 114, pl. xii, fig. 9.
1849. *Vermetus Bognoriensis*, Brown, Ill. Foss. Conch. Gt. Brit., p. 84, pl. xliii, fig. 1.[1]
1854. *Vermicularia Bognoriensis*, Morris, Catal. Brit. Foss., p. 94.
1878. *Vermicularia Bognoriensis*, Dixon, Geol. Sussex, ed. 2, p. 436, pl. xiv, fig. 3 *a*.
1888. *Vermicularia bognoriensis*, Prestwich, Geology, vol. ii, p. 352, fig. 177 *b*.
1912. *Vermetus* (*Burtinella*) *bognoriensis*, Cossmann, Ess. Paléoconch. compar., vol. ix, p. 141.

Specific Characters.—Shell small, tubular, spiral portion subdiscoidal, concave and furrowed, with a rounded margin, sometimes thickened.

Dimensions.—H. 4—5 mm. Diam. of coil, 15—20 mm.

Distribution.—Not known living.

Fossil: Boxstone fauna (A. Bell). Waltonian Crag: Walton-on-Naze, Beaumont, Little Oakley. Newbournian: Sutton.

Eocene: London Clay—Bognor, Highgate, Isle of Sheppey. Belgium.

Remarks.—Imperfect specimens of this shell are not infrequently found in the Crag. They are of course derivative from some earlier deposit.

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[1] Brown's figure (*op. cit.*) shows the prolonged tube of the perfect shell, as does that of Prestwich.

PLATE XXXIII.

Fig.		Page.
1.	*Helix* (*Macularia*) *Ogdeni*, Kennard and B. B. Woodward. Ramsholt. (Ogden Collection)	303
2.	*Mitra cornicula* (Linné). Wexford. (Harmer Collection)[1] . .	311
3.	Ditto. Wexford. (Harmer Collection)	311
4.	*Mitra ebenus*, Lamarck. Gomer. (Cambridge Museum) . .	310
5.	*Volutomitra groenlandica* (Möller). Recent. (Harmer Collection) .	312
6.	Ditto. Wexford. (Harmer Collection)	312
7.	*Cypræa* (*Erosaria*) *spurca* (Linné). Recent. (Harmer Collection) .	304
8.	Ditto. Kilbride, Wicklow. (Jermyn Street Museum) . .	304
9.	*Columbella* (*Mitrella*) *semicaudata* (Bonelli). Asti. (Harmer Collection)	307
10.	Ditto. Walton-on-Naze. (Harmer Collection) . . .	307
11.	*Columbella* (*Mitrella*) *erythrostoma* (Bonelli). Asti. (Harmer Collection)	306
12.	Ditto. Walton-on-Naze. (Harmer Collection) . . .	306
13.	*Columbella* (*Mitrella*) *sulcata* (J. Sowerby), var. *abbreviata*, A. Bell. Little Oakley. (Harmer Collection) . . .	307
14.	var. *typica*. Little Oakley. (Harmer Collection) . .	307
15.	ditto. Little Oakley. (Harmer Collection) . . .	307
16.	var. *elongata*, nov. Walton-on-Naze. (Harmer Collection) .	308
17.	ditto. Little Oakley. (Harmer Collection) . . .	308
18.	*Columbella* (*Mitrella*) *sulculata* (S. V. Wood). Little Oakley. (Harmer Collection)	308
19.	Ditto. Little Oakley. (Harmer Collection) . . .	308
20.	*Columbella* (*Columbellopsis*) *Borsoni* (Bellardi). Little Oakley. (Harmer Collection)	309
21.	Ditto. Italian Miocene. (Harmer Collection) . . .	309
22.	*Nassa solida*, S. V. Wood, MS. St. Erth. (Cambridge Museum) .	313
23.	*Nassa mutabilis* (Linné). St. Erth. (British Museum) . .	314
24.	Ditto. Recent. (Harmer Collection)	314
25.	Ditto. Asti. (Harmer Collection)	314
26.	var. *erthensis*, S. V. Wood, MS. St. Erth. (British Museum) .	316
27.	*Nassa* (*Hinia*) *recticostata* (Bellardi). St. Erth. (Cambridge Museum)	320
28.	*Nassa* (*Niotha*) *clathrata* (Born). Asti. (Harmer Collection) .	317
29.	var. A. (Born). Boyton. (Cambridge Museum) . .	317
30.	ditto. Gomer. (Cambridge Museum) . . .	317

[1] So far as the fossils are figured in these plates, Mr. Bell's collection has been amalgamated with my own.

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PLATE XXXIV.

Fig.		Page.
1.	*Nassa (Hinia) reticulata* (Linné). Wexford. (Harmer Collection) .	318
2.	Ditto. Recent. (Harmer Collection)	318
3.	var. *nitida* (Jeffreys). Wexford. (Irish Survey) . .	319
4.	ditto. Recent. (Harmer Collection) . . .	319
5.	ditto. Hunstanton gravel. (Harmer Collection) . .	319
6.	*Nassa (Hima) pygmæa* (Lamarck). Nar Valley. (Norwich Museum) .	326
7.	Ditto. Recent. (Harmer Collection) . . .	326
8.	*Nassa (Hima) incrassata* (Ström). Wexford. (Harmer Collection) .	324
9.	Ditto. Recent. (Harmer Collection)	324
10.	Ditto. Italian Pliocene. (Harmer Collection) . . .	324
11.	*Nassa (Hima) turonica* (Deshayes). St. Erth. (British Museum) .	328
12.	Ditto. Touraine. (Harmer Collection) . . .	328
13.	Ditto. St. Erth. (British Museum)	328
14.	Ditto. Touraine. (Harmer Collection) . . .	328
15.	*Nassa (Amycla) Edwardsi* (Fischer). Boyton. (Cambridge Museum) .	332
16.	*Nassa (Hinia) trivittata* (Say). Macclesfield. (British Museum) .	321
17.	Ditto. Recent, New England. (Harmer Collection) . .	321
18.	*Nassa (Hinia) propinqua* (J. Sowerby). Little Oakley. (Harmer Collection)	322
19.	Ditto. Little Oakley. (Harmer Collection) . . .	322
20.	*Nassa (Amycla) labiosa* (J. Sowerby). Ficarazzi. (Harmer Collection)	330
21.	Ditto. Little Oakley. (Harmer Collection) . . .	330
22.	*Nassa (Amycla) gigantula* (Bonelli, MS.). Ficarazzi. (Harmer Collection)	331
23.	Ditto. Wexford. (Harmer Collection)	331
24.	*Nassa (Amycla) semistriata* (Brocchi). Italian Pliocene. (Harmer Collection)	328
25.	*Nassa (Telasco) costulata* (Renieri). var. *tenuicosta*, Bucquoy, Dautzenberg and Dollfus. Oakley. (Harmer Collection)	323
26.	ditto. Recent. (Harmer Collection) . . .	323
27.	*Desmoulea conglobata* (Brocchi). Beaumont. (Cambridge Museum) .	333
28.	*Purpura tetragona* (J. Sowerby). var. *intermedia*, S. V. Wood. Foxhall. (Ipswich Museum) .	336
29.	*Purpura lapillus* (Linné). var. *menapiæ*, nov. Wexford. (Harmer Collection) . .	334
30.	Ditto. ditto. Wexford. (Harmer Collection) . . .	334
31.	var. *butleyensis*, F. W. Harmer. Isle of Man. (Harmer Collection)	335
32.	var. *brevis*, S. V. Wood. Wexford. (Harmer Collection) .	335
33.	var. *minor*, Jeffreys. Wexford. (Harmer Collection) . .	335
34.	var. *ventricosa*, nov. Bramerton. (Norwich Museum) .	335

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PLATE XXXV.

Fig.		Page.
1.	*Purpura lapillus* (Linné), var. *incrassata* (J. Sowerby). Boyton. (York Museum)	335
2.	*Buccinum finmarchianum*, Verkrüzen. Wexford. (Harmer Collection)	334
3.	*Buccinum undatum*, Linné, var. *pulchra*, F. W. Harmer. Wexford. (Harmer Collection)	333
4.	*Nassa Kennardi*, F. W. Harmer. Antwerp. (Harmer Collection)	316
5.	Ditto. St. Erth. (British Museum)	316
6.	*Nassa* (*Niotha*) *emiliana* (Mayer). St. Erth. (Cambridge Museum)	317
7.	*Ocinebra tortuosa* (J. Sowerby). Coralline Crag, Gedgrave. (Harmer Collection)	342
8.	Ditto. Red Crag, Little Oakley. (Harmer Collection)	342
9.	var. *minor*, F. W. Harmer. Little Oakley. (Harmer Collection)	343
10.	var. *clathrata*, nov. Little Oakley. (Harmer Collection)	343
11.	*Ocinebra Reedii* (S. V. Wood). Boyton. (York Museum)	344
12.	*Ocinebra pseudo-Nystii* (S. V. Wood). Boyton. (British Museum)	343
13.	var. *similis*, nov. Little Oakley. (Harmer Collection)	344
14.	*Ocinebra tortuosa* (J. Sowerby), var. *clathrata*, nov. Newbourn. (Cambridge Museum)	343
15.	*Ocinebra Canhami* (S. V. Wood). Waldringfield. (Ipswich Museum)	345
16.	Ditto. Boyton. (Cambridge Museum)	345
17.	*Ocinebra erinacea* (Linné). Wexford. (Harmer Collection)	341
18.	*Ocinebra* (*Ocinebrina*) *aciculata* (Lamarck). Beaumont. (Harmer Collection)	347
19.	Ditto. Recent. (Harmer Collection)	347
20.	*Murex* (*Alipurpura*) *elegantula*, nov. Boyton. (York Museum)	340
21.	*Murex* (*Pteropurpura*) *boytonensis* (F. W. Harmer). Boyton. (York Museum)	339
22.	*Pisania exigua* (Dujardin). Waldringfield. (York Museum)	336
23.	Ditto. Little Oakley. (Harmer Collection)	336
24.	*Eupleura caudata* (Say). Recent. (Harmer Collection)	337
25.	var. *Crowfootii* (S. V. Wood). Boyton. (Crowfoot Collection)	338

J. Green, del.

London Stereoscopic Co. Imp.

PLATE XXXVI.

Fig.		Page.
1.	*Ocinebra* (*Ocinebrina*) *funiculosa* (Borson). St. Erth. (British Museum)	348
2.	Ditto. Italian Pliocene. (Harmer Collection) . . .	348
3.	*Trophon* (*Boreotrophon*) *clathratus* (Linné). Little Oakley. (Harmer Collection)	350
4.	Ditto. Wexford. (Harmer Collection)	350
5.	Ditto. Uddevalla. (Harmer Collection) . . .	350
6.	var. *minor*, nov. Wexford. (Harmer Collection) . .	351
7.	var. *attenuata*, nov. Wexford. (Harmer Collection) . .	352
8.	ditto. Little Oakley. (Harmer Collection) . . .	352
9.	var. *exilis*, nov. Wexford. (Harmer Collection) . .	352
10.	ditto. Isle of Man. (Harrison Collection) . . .	352
11.	*Trophon* (*Trophonopsis*) *Bailyi* (A. Bell). Wexford. (Harmer Collection)	355
12.	*Trophon* (*Trophonopsis*) *muricatus* (Montagu). Wexford. (Harmer Collection)	354
13.	var. *similis* (F. W. Harmer). Wexford. (Harmer Collection) .	354
14.	ditto. Wexford. (Harmer Collection) . . .	354
15.	var. *Bellii*, nov. Wexford. (Harmer Collection) . .	354
16.	var. *cancellata*, nov. Wexford. (Harmer Collection) . .	355
17.	*Ocinebra craticulata* (Fabricius). Recent. (Harmer Collection) .	345
18.	Ditto. Wexford. (Harmer Collection)	345
19.	Ditto. Wexford. (Harmer Collection)	345
20.	var. *reticulata* nov. Bridlington. (Cambridge Museum) .	346
21.	ditto. Wexford. (Harmer Collection) . . .	346
22.	*Trophon* (*Boreotrophon*) *truncatus* (Ström). Wexford. (Harmer Collection)	349
23.	Ditto. Recent. (Harmer Collection)	349
24.	var. *intermedia*, nov. Wexford. (Harmer Collection) .	350
25.	var. *major* (Brøgger). Wexford. (Harmer Collection) .	350
26.	*Neptunea antiqua* (Linné). Wexford. (Harmer Collection) . .	368
27.	var. *inversa*, nov. Wexford. (Harmer Collection) . .	368
28.	ditto. Recent. (Norwich Museum) . . .	368
29.	*Neptunea despecta* (Linné), var. *tornata* (Gould). Wexford. (Harmer Collection)	369
30.	*Neptunea contraria* (Linné), var. *informis*, F. W. Harmer. Bramerton. (British Museum)	367
31.	ditto. Wexford. (Harmer Collection) . . .	367

London Stereoscopic Co. Imp.

PLATE XXXVII.

Fig.		Page.
1.	*Neptunea tenuistriata*, sp. nov. Recent, Newfoundland. (Harmer Collection)	369
2.	Ditto. Bridlington. (Cambridge Museum) . . .	369
3.	*Neptunea contraria* (Linné). Boyton. (York Museum) . .	366
4.	var. *carinata* (S. V. Wood). Bridlington. (Cambridge Museum)	367
5.	ditto. Antwerp. (Harmer Collection) . . .	367
6.	*Euthria gracilis*, Locard. Isle of Man. (Harrison Collection) .	362
7.	*Euthria cornea* (Linné). St. Erth. (British Museum) . .	361
8.	Ditto. Italian Pliocene. (Harmer Collection) . . .	361
9.	*Atractodon elegans*, Charlesworth. Antwerp. (Harmer Collection) .	364
10.	var. *inflata*, nov. Antwerp. (Harmer Collection) . .	365
11.	ditto. Waldringfield. (York Museum) . . .	365
12.	ditto. Little Oakley. (Harmer Collection) . . .	365
13.	ditto. Little Oakley. (Harmer Collection) . . .	365
14.	*Sipho latericeus* (Möller). Moel Tryfaen. (Jermyn Street Museum) .	374
15.	*Troschelia berniciensis* (King). Little Oakley. (Harmer Collection) .	363
16.	Ditto. Recent. (Harmer Collection)	363

J. Green, del.

London Stereoscopic Co. Imp.

PLATE XXXVIII.

Fig.		Page.
1.	*Sipho gracilis* (Da Costa). Wexford. (Harmer Collection)	372
2.	Ditto. Wexford. (Harmer Collection)	372
3.	var. *convoluta* (Jeffreys). Wexford. (Harmer Collection)	372
4.	ditto. Wexford. (Harmer Collection)	372
5.	*Sipho islandicus* (Chemnitz). Recent. (Harmer Collection)	373
6.	Ditto. Wexford. (Harmer Collection)	373
7.	Ditto. Wexford. (Harmer Collection)	373
8.	Ditto. Lewis. (British Museum)	373
9.	*Sipho propinquus* (Alder). Wexford. (Harmer Collection)	375
10.	*Sipho torrus* (Locard). Recent. (Dautzenberg Collection)	371
11.	Ditto. Wexford. (Harmer Collection)	372
12.	*Sipho Jeffreysianus* (Fischer). Wexford. (Harmer Collection)	373
13.	*Sipho pygmæus* (Gould). Bridlington. (York Museum)	374
14.	Ditto. Recent, New England coast. (Harmer Collection)	374
15.	Ditto. Bridlington. (Cambridge Museum)	374
16.	*Fusus Rigaccii*, Cerulli-Irelli. Isle of Man. (Harrison Collection)	360
17.	*Fusus imperspicuus*, S. V. Wood. Coralline Crag. (York Museum)	360
18.	Ditto. Gomer pit. (Cambridge Museum)	360
19.	*Trophon Gunneri* (Lovén). Bridlington. (York Museum)	352
20.	Ditto. Uddevalla. (Harmer Collection)	352
21.	var. *Coddii*, nov. Wexford. (Harmer Collection)	353
22.	*Trophon mediglacialis* (S. V. Wood). Billockby. (Norwich Museum)	353

J. Green del. London Stereoscopic Co. Imp.

PLATE XXXIX.

Fig.		Page
1.	*Pleurotoma contigua* (Brocchi). Scaldisien, Antwerp. (Harmer Collection)	377
2.	Ditto. Italian Pliocene. (Harmer Collection)	377
3.	*Raphitoma concinnata* (S. V. Wood). Coralline Crag. (Jermyn Street)	382
4.	Ditto. Coralline Crag. (Cambridge Museum)	382
5.	*Raphitoma nuperrima* (Tiberi). Coralline Crag. (Cambridge Museum)	386
6.	*Raphitoma nevropleura* (Brugnone). Foxhall. (Jermyn Street)	383
7.	*Raphitoma compacta* (Etheridge and Bell). St. Erth. (Jermyn Street)	385
8.	*Raphitoma Hörnesii* (Mayer). St. Erth. (Jermyn Street)	387
9.	*Raphitoma consimilis*, sp. nov. Gedgrave. (Cambridge Museum)	387
10.	*Raphitoma mitrula* (S. V. Wood). Little Oakley. (Harmer Collection)	384
11.	Ditto. Little Oakley. (Harmer Collection)	384
12.	Ditto. Little Oakley. (Harmer Collection)	348
13.	Ditto. Little Oakley. (Harmer Collection)	384
14.	*Raphitoma substriolata*, sp. nov. Recent. (Harmer Collection)	385
15.	Ditto. Little Oakley. (Harmer Collection)	385
16.	*Raphitoma tenuistriata* (A. Bell). Wexford. (Harmer Collection)	384
17.	*Raphitoma Keepingi* (Etheridge and Bell). St. Erth. (Cambridge Museum)	388
18.	*Mangilia costato-striata* (S. V. Wood). St. Erth. (Cambridge Museum)	381
19.	Ditto. St. Erth. (Cambridge Museum)	381
20.	*Mangilia assimilis*, sp. nov. Little Oakley. (Harmer Collection)	381
21.	*Mangilia Bertrandi* (Payraudeau). Little Oakley. (Harmer Collection)	380
22.	Ditto. Monte Mario. (Harmer Collection)	380
23.	Ditto. Gedgrave. (Cambridge Museum)	380
24.	*Mangilia Gwynii* (Etheridge and Bell). St. Erth. (British Museum)	382
25.	*Bela Sarsii*, Verrill. Recent. (Harmer Collection)	391
26.	Ditto. East Runton. (Norwich Museum)	391
27.	*Bela elegans* (Möller). Bridlington. (Headley Collection)	393
28.	*Bela angulosa*, G. O. Sars. Bridlington. (Cambridge Museum)	392
29.	*Bela bicarinata* (Couthouy). Bridlington. (Headley Collection)	393
30.	*Bela multistriata* (Jeffreys). Bridlington. (Headley Collection)	394
31.	*Bela borealis* (Reeve). Wexford. (Harmer Collection)	392
32.	*Bela Trevelyana* (Turton). Wexford. (Harmer Collection)	394
33.	*Clathrurella minuta*, sp. nov. Ramsholt. (Ipswich Museum)	379
34.	*Clathrurella linearis* (Montagu). Wexford. (Harmer Collection)	379
35.	*Drillia Jeffreysii*, sp. nov. Coralline Crag. (Ipswich Museum)	377
36.	*Drillia galerita* (Philippi). Little Oakley. (Harmer Collection)	378
37.	*Donovania lineolata* (Tiberi). Selsey. (British Museum)	390
38.	*Donovania multilineata* (Etheridge and Bell). St. Erth. (British Museum)	390
39.	*Donovania candidissima* (Philippi). St. Erth. (British Museum)	389
40.	*Brocchinia mitræformis* (Brocchi). Gedgrave. (Harmer Collection)	396
41.	var. *costata*, nov. Felixstow. (Harmer Collection)	397
42.	*Admete viridula* (Fabricius). Little Oakley. (Harmer Collection)	406
43.	Ditto. Little Oakley. (Harmer Collection)	406
44.	Ditto. Little Oakley. (Harmer Collection)	406
45.	Ditto. Gomer pit. (Cambridge Museum)	406
46.	Ditto. Wexford. (Harmer Collection)	406
47.	Ditto. Orford. (Cambridge Museum)	406
48.	var. *Couthouyi* (Jay), Boyton. (Jermyn Street)	407
49.	ditto. Butley. (Harmer Collection)	407
50.	*Admete Wouweri*, sp. nov. Scaldisien, Antwerp. (Harmer Collection)	410
51.	*Admete gracilenta* (S. V. Wood). Boyton. (Cambridge Museum)	410
52.	Ditto. (Ipswich Museum)	410

J. Green del.

London Stereoscopic Co. Imp.

PLATE XL.

Fig.		Page.
1.	*Trigonostoma ampullaceum* (Brocchi). Asti. (Harmer Collection)	399
2.	*Trigonostoma* (*Ventrilia*) *acutangulum* (Faujas-de-St. Fond). Red Crag. (Cambridge Museum)	401
3.	*Trigonostoma umbilicare* (Brocchi). Asti. (Harmer Collection)	400
4.	Ditto. Waldringfield. (Ipswich Museum)	400
5.	*Merica contorta* (Basterot). Boyton. (Jermyn Street)	394
6.	Ditto. Boyton. (Cambridge Museum)	394
7.	Ditto. Little Oakley. (Harmer Collection)	394
8.	*Bonellitia granulata* (Nyst). Bentley. (Harmer Collection)	405
9.	*Bonellitia incerta*, sp. nov. Gedgrave. (Norwich Museum)	405
10.	*Bonellitia serrata* (Bronn). Boyton. (Cambridge Museum)	404
11.	Ditto. Italian Pliocene. (Harmer Collection)	404
12.	*Bonellitia evulsa* (Solander). Little Oakley. (Harmer Collection)	402
13.	Ditto. Little Oakley. (Harmer Collection)	402
14.	var. *semicostata* (Sacco). Edgehem. (Harmer Collection)	402
15.	*Sveltia varicosa* (Brocchi). Asti. (Harmer Collection)	398
16.	Ditto. Waldringfield. (Ipswich Museum)	398
17.	Ditto. Scaldisien, Antwerp. (Harmer Collection)	398
18.	*Sveltia Lajonkairei* (Nyst). Gedgrave. (Jermyn Street)	397
19.	Ditto. Scaldisien, Antwerp. (Harmer Collection)	397
20.	Ditto. Little Oakley. (Harmer Collection)	397
21.	Ditto. Felixstow. (York Museum)	397
22.	*Potamides* (*Ptychopotamides*) *tricinctus* (Brocchi), var. *inornata* (S. V. Wood). Waldringfield. (Cambridge Museum)	411
23.	var. *typica*, nov. Little Oakley. (Harmer Collection)	411
24.	ditto. Little Oakley. (Harmer Collection)	411
25.	ditto. Little Oakley. (Harmer Collection)	411
26.	var. *icenica*, nov. Yarn Hill. (Cambridge Museum)	412
27.	*Trophon* (*Trophonopsis*) *Harmeri* (A. Bell). Wexford. (Harmer Collection)	356
28	Ditto. Wexford. (Harmer Collection)	356
29.	*Trophon* (*Trophonopsis*) *barvicensis* (Johnston). Recent. (Harmer Collection)	357
30.	Ditto. Wexford. (Harmer Collection)	357

J. Green. del

London Stereoscopic Co. Imp.

PLATE XLI.

Fig.		Page.
1.	*Bittium reticulatum* (Da Costa). Recent. (Harmer Collection) .	414
2.	Ditto. Aldeby. (Ipswich Museum)	414
3.	Ditto. Ramsholt. (York Museum)	414
4.	var. *trinodosa* (Etheridge and Bell). St. Erth. (Harmer Collection) .	416
5.	*Bittium punctulum* (S. V. Wood). Walton-on-Naze. (British Museum)	418
6.	Ditto. Little Oakley. (Harmer Collection) . . .	418
7.	*Bittium lacteum* (Philippi). Little Oakley. (Harmer Collection) .	416
8.	Ditto. Recent. (Harmer Collection)	416
9.	*Bittium robustum*, sp. nov. Scaldisien, Antwerp. (Harmer Collection)	417
10.	Ditto. Little Oakley. (Harmer Collection) . . .	417
11.	*Læocochlis granosa* (S. V. Wood). Cor. Crag. (Cambridge Museum) .	427
12.	Ditto. Little Oakley. (Harmer Collection) . . .	427
13.	Ditto. Cor. Crag. (Harmer Collection) . . .	427
14.	*Cerithiopsis Barleei*, Jeffreys. Little Oakley. (Harmer Collection) .	419
15.	Ditto. Recent. (Harmer Collection)	419
16.	*Cerithiopsis Metaxæ* (Delle Chiaje). Recent. (Harmer Collection) .	422
17.	Ditto. Recent. (Harmer Collection)	422
18.	Ditto. Cor. Crag, Sutton. (British Museum) . . .	422
19.	Ditto. Boyton. (Jermyn Street)	422
20.	*Cerithiopsis tubercularis* (Montagu). Boyton. (Jermyn Street) .	420
21.	Ditto. Recent. (Norwich Museum)	420
22.	*Cerithiopsis minima* (Brusina). Cor. Crag, Sutton. (Norwich Museum)	423
23.	var. *ovoides*, Cerulli-Irelli. Cor. Crag, Sutton. (Norwich Museum)	423
24.	*Newtoniella* (*Seila*) *trilineata* (Philippi). Cor. Crag. (Cambridge Museum)	424
25.	*Triforis perversa* (Linné), var. *adversa* (Montagu). Gedgrave. (Jermyn Street)	425
26.	*Aporrhais pes-pelicani* (Linné). Gedgrave. (Harmer Collection) .	432
27.	Ditto. Recent. (Harmer Collection)	432
28.	Ditto. Little Oakley. (Harmer Collection) . . .	432
29.	Ditto. East Winch. (Norwich Museum) . . .	432
30.	var. *minor*, Bucquoy, etc. Boyton. (Harmer Collection) .	434
31.	*Aporrhais Uttingerianus* (Risso). Scaldisien, Antwerp. (Harmer Collection)	435
32.	Ditto. Italian Miocene. (Harmer Collection) . . .	435
33.	*Aporrhais Serresianus* (Michaud). Recent, Bergen. (Harmer Collection)	436
34.	var. *Macandreæ*, Jeffreys. Scaldisien, Antwerp. (Harmer Collection)	437

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PLATE XLII.

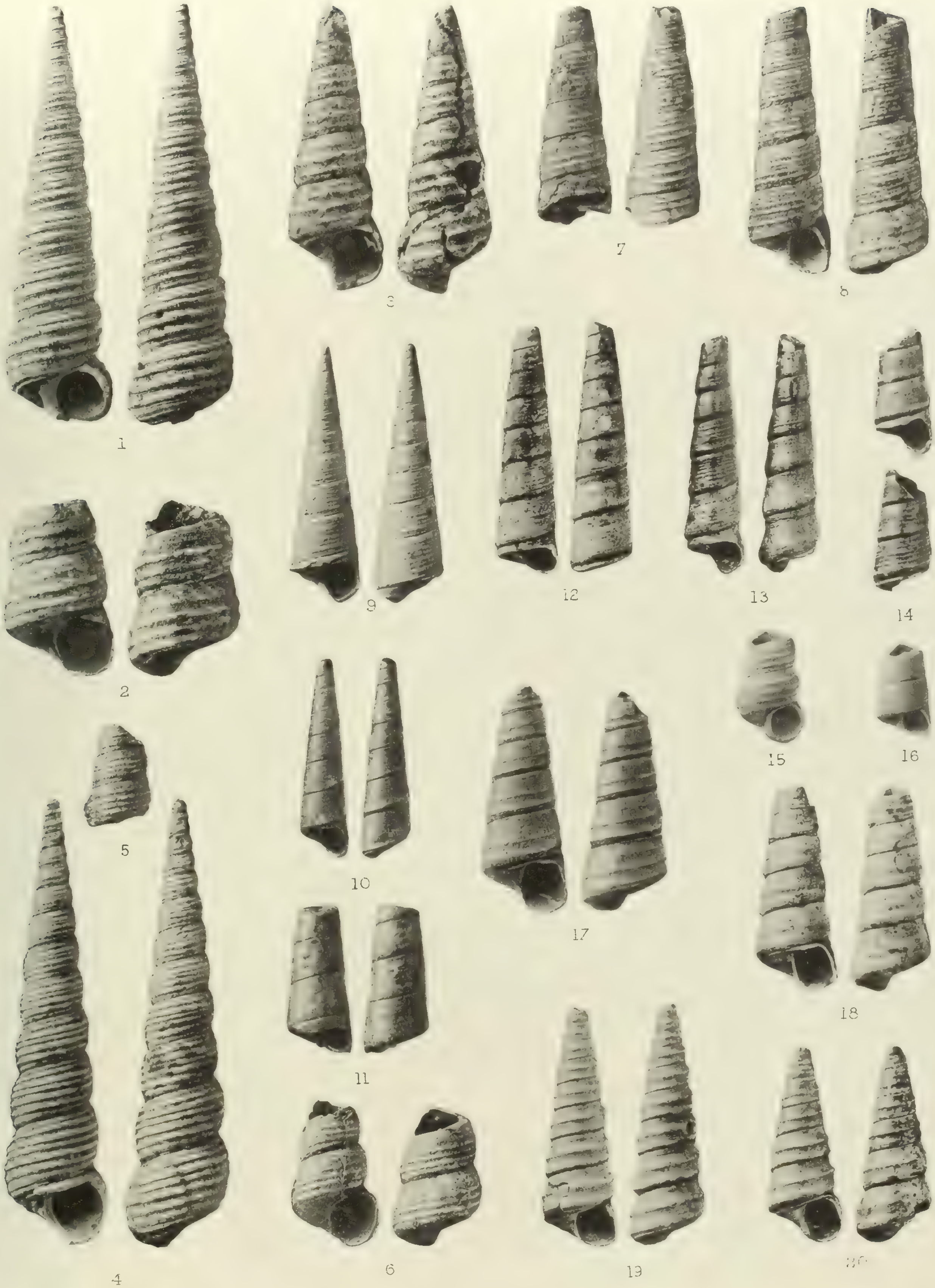
Fig.		Page.
1.	*Turritella* (*Haustator*) *incrassata* (J. Sowerby). Gedgrave. (Harmer Collection)	446
2.	Ditto. Little Oakley. (Harmer Collection) . . .	446
3.	Ditto. Casterlien, Antwerp. (Harmer Collection) . .	446
4.	*Turritella* (*Haustator*) *erthensis*, sp. nov. St. Erth. (Cambridge Museum)	451
5.	*Turritella* (*Haustator*) *incrassata* (J. Sowerby). Little Oakley. (Harmer Collection)	446
6.	Ditto. Little Oakley. (Harmer Collection) . . .	446
7.	Ditto. Scaldisien, Antwerp. (Harmer Collection) . .	446
8.	var. *minor*, nov. Middle Glacial, Billockby. (Norwich Museum)	448
9.	ditto. Middle Glacial, Billockby. (Norwich Museum) .	448
10.	*Turritella* (*Haustator*) *vermicularis* (Brocchi). Waldringfield. (Ipswich Museum)	449
11.	*Turritella* (*Haustator*) *triplicata* (Brocchi). Little Oakley. (Harmer Collection)	448
12.	Ditto. Italian Pliocene. (Harmer Collection) . . .	448
13.	Ditto. Little Oakley. (Harmer Collection) . . .	448
14.	Ditto. Miocene, Touraine. (Harmer Collection) . . .	448
15.	*Turritella* (*Zaria*) *subangulata* (Brocchi). Little Oakley. (Harmer Collection)	443
16.	Ditto. Little Oakley. (Harmer Collection) . . .	443
17.	var. *mediocarinata* (de Gregorio). Italian Pliocene. (Harmer Collection)	444
18.	*Turritella* (*Haustator*) *crenulata* (Nyst). Oligocene, Belgium. (Cambridge Museum)	452
19.	Ditto. Little Oakley. (Harmer Collection) . . .	452

J. Green del.

London Stereoscopic Co. Imp.

PLATE XLIII.

Fig.		Page.
1.	*Turritella* (*Haustator*) *vermicularis* (Brocchi). Asti. (Harmer Collection)	449
2.	Ditto. Little Oakley. (Harmer Collection) . . .	449
3.	Ditto. Little Oakley. (Harmer Collection) . . .	449
4.	var. *lineolato-cincta* (Sacco). Asti. (Harmer Collection) .	450
5.	ditto. Little Oakley. (Harmer Collection) . . .	450
6.	ditto. Walton-on-the-Naze. (Harmer Collection) . .	450
7.	*Turritella* (*Haustator*) *tornata* (Brocchi). Asti. (Harmer Collection) .	455
8.	Ditto. Cor. Crag, Sutton. (Ipswich Museum) . . .	455
9.	*Turritella* (*Haustator*) *marginalis* (Brocchi). Miocene, Touraine. (Harmer Collection)	452
10.	Ditto. Bentley. (Ipswich Museum)	452
11.	Ditto. Little Oakley. (Harmer Collection) . . .	452
12.	*Turritella* (*Haustator*) *imbricataria* (Lamarck). Waldringfield. (Cambridge Museum)	454
13.	Ditto. Waldringfield. (Norwich Museum) . . .	454
14.	Ditto. Little Oakley. (Harmer Collection) . . .	454
15.	*Turritella communis*, Risso. Wexford. (Harmer Collection) .	440
16.	*Turritella* (*Haustator*) *incrassata* (J. Sowerby). Wexford. (Harmer Collection)	446
17.	*Turritella* (*Haustator*) *biplicata* (Bronn). Little Oakley. (Harmer Collection)	455
18.	Ditto. Little Oakley. (Harmer Collection) . . .	455
19.	*Turritella* (*Archimediella*) *bicarinata* (Eichwald). Miocene, Touraine. (Harmer Collection)	456
20.	Ditto. Little Oakley. (Harmer Collection) . . .	456



J. Green del.

London Stereoscopic Co Imp.

PLATE XLIV.

Fig.		Page.
1.	*Turritella communis*, Risso. Recent, British seas. (Harmer Collection)	440
2.	Ditto. Easton Bavent. Icenian. (Harmer Collection)	440
3.	Ditto. Bramerton. Icenian. (Norwich Museum)	440
4.	Ditto. Blackpool. Pleistocene. (Harmer Collection)	440
5.	Ditto. Wexford. (Harmer Collection)	440
6.	Ditto. Recent, Mediterranean. (Harmer Collection)	440
7.	*Turritella tricarinata* (Brocchi). Monte Pellegrino. (Harmer Collection)	438
8.	Ditto. Little Oakley. (Harmer Collection)	438
9.	Ditto. Waldringfield. (Ipswich Museum)	438
10.	var. *bicincta* (S. V. Wood). Little Oakley. (Harmer Collection)	439
11.	*Turritella turris*, Basterot. Miocene, Touraine. (Harmer Collection)	443
12.	Ditto. (?). Little Oakley. (Harmer Collection)	443
13.	*Turritella (Zaria) decipiens* (Monterosato). Little Oakley. (Harmer Collection)	445
14.	Ditto. Recent. (Harmer Collection)	445
15.	*Turritella erosa*, Couthouy. Bridlington. (Cambridge Museum)	442
16.	*Turritella (Haustator) planispira* (S. V. Wood). Little Oakley. (Harmer Collection)	453
17.	*Buccinum undatum*, Linné, var. *pulchra*, F. W. Harmer. Kelsey Hill. (British Museum)	333
18.	Ditto. Wexford. (Harmer Collection)	333
19.	*Pisania exigua* (Dujardin). Recent. (Harmer Collection)	336
20.	*Trophon (Trophonopsis) muricatus* (Montagu), var. *similis* (?) F. W. Harmer. Wexford. (Harmer Collection)	354
21.	*Searlesia Ravni*, F. W. Harmer. Little Oakley. (Harmer Collection)	359
22.	*Fusus Waelii*, Nyst. Belgian Oligocene. (Norwich Museum)	359
23.	*Vermetus (Burtinella) bognoriensis* (Mantell). Little Oakley. (Harmer Collection)	461
24.	*Vermetus (Bivonia) triqueter* (Bivona). Little Oakley. (Harmer Collection)	460
25.	Ditto. Little Oakley. (Harmer Collection)	460
26.	Ditto. Sicilian Pliocene, Ficarazzi. (Harmer Collection)	460
27.	Ditto. Waldringfield. (York Museum)	460
28.	Ditto. Wexford. (Harmer Collection)	460
29.	*Vermetus (Petaloconcha) glomeratus* (Linné). Little Oakley. (Harmer Collection)	459
30.	Ditto. Italian Pliocene. (Harmer Collection)	459
31.	Ditto. Little Oakley. (Harmer Collection)	459
32.	Ditto. Little Oakley. (Harmer Collection)	459
33.	*Vermetus (Petaloconcha) intortus* (Lamarck). Italian Pliocene. (Harmer Collection)	457
34.	Ditto. Little Oakley. (Harmer Collection)	457
35.	*Trichotropis Kröyeri*, Philippi. Little Oakley. (Harmer Collection)	429
36.	*Trichotropis borealis*, Broderip and Sowerby. Waldringfield. (Ipswich Museum)	428
37.	Ditto. Recent, Tromsö. (Harmer Collection)	428
38.	Ditto. Cor. Crag. (Cambridge Museum)	428
39.	*Trichotropis insignis*, Middendorff. Recent, Alaska. (Harmer Collection)	430
40.	var. *Woodii*, nov. Bridlington. (Cambridge Museum)	430

PALÆONTOGRAPHICAL SOCIETY, 1916

Harmer, Crag Mollusca

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A MONOGRAPH

OF THE

BRITISH PALÆOZOIC

ASTEROZOA

BY

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PART III.

Pages 109—168; Plates VI—XIII.

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2. **Uranaster ramseyensis** (Hicks). Plate VI, figs. 1—4; Text-figs. 64—66.

1873.	*Palasterina ramseyensis*,	Hicks, Quart. Journ. Geol. Soc., vol. xxix, p. 51, pl. iv, figs. 21—23.
1874.	„ „	Woodward, Geol. Mag., dec. ii, vol. i, p. 96.
1914.	*Palasterina ?* „	Schuchert, Fossilium Catalogus, Animalia, pt. 3, p. 31.
1915.	*Palasterina ?* „	Schuchert, Bull. 88, U.S. Nat. Mus., p. 154.

Material.—Two specimens of the species are known, both of which have a counterpart. They are from the Lightbody Collection, and are in the Museum of the Victoria University, Manchester. L. 11036*a* is the original of Hicks' fig. 21; its counterpart is L. 11038. L. 11037 is the original of fig. 22, and its counterpart

TEXT-FIG. 64.—Wash drawing of a portion of the apical surface of *Uranaster ramseyensis* (L. 11038). *I.M.*, infero-marginalia; *R.*, radialia; *S.M.*, supero-marginalia. × 5.

is L. 11036*b*. The original of fig. 22, L. 11037, is chosen by me as the holotype of the species.

Specific Characters.—Much smaller than *U. kinahani*, r measuring 4 mm. Adambulacralia from base of arm onwards outnumber the infero-marginalia.

Apical Surface (Plate VI, figs. 2, 4; Text-fig. 64).—The apical surface of the arm is strikingly similar to that of *U. kinahani*, most of the essential differences being those which we should expect to find in a more primitive form from a lower geological horizon. As in *U. kinahani* and *Petraster speciosus* the boundary of the apical surface is formed, not by the supero-marginalia, but by the infero-marginalia (compare the Text-fig. 64 with Text-fig. 60, p. 106, and Text-fig. 67, p. 111). The supero-marginalia in the disc are stellate in the three species (compare the same Text-figures). The radialia are more persistent and more readily recognisable in *U. ramseyensis* than in *U. kinahani* (compare Text-fig. 64 with Text-fig. 61, p. 106). This would be expected because the

first-named species is the more primitive. The appearance towards the distal extremity of the arms is similar in both species and highly characteristic. Both adradialia and supero-marginalia if seen in slight profile view, look half-moon-shaped. This is well seen in the case of *U. kinahani* in the lower left-hand side of Pl. V, fig. 4, and in *U, ramseyensis* in Text-fig. 64. Many of the infero-marginalia have distinct swellings, each of which carried a long prominent spine. Schuchert notes that the distal infero-marginalia of *P. speciosus* also tend to become strongly convex with "one prominent point for an articulatory spine" (1915, p. 143). This is a further point which enables one to link up an English *Uranaster* with the American *P. speciosus*. The infero-marginalia of *U. kinahani* appear to be much flatter, and I have not been able to recognise prominent spines with certainty.

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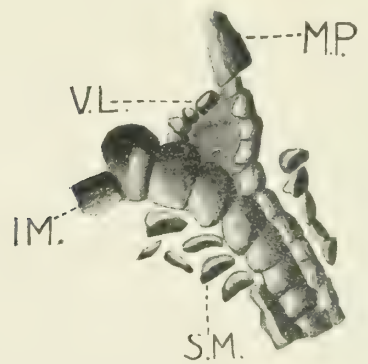

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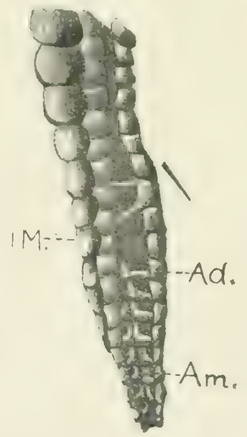


Text-fig. 65.—Wash drawing of a portion of the oral surface of *Uranaster ramseyensis* (L. 11036 *b*) to show the disc. *I.M.*, infero-marginalia; *M.P.*, mouth-angle plates; *S.M.*, supero-marginalia; *V.L.*, ventro-lateralia. × 7.

Text-fig. 66.—Wash drawing of a portion of the oral surface of *Uranaster ramseyensis* (L. 11036 *a*) to show the ambulacral groove. *Ad.*, adambulacralia; *Am.*, ambulacralia; *I.M.*, infero-marginalia. × 5.

Oral Surface (Plate VI, figs. 1, 3; Text-figs. 65, 66).—So far as it can be made out, the oral aspect is almost precisely that of *U. kinahani*, except that the adambulacralia outnumber the infero-marginalia. Unfortunately, there is no good view of the interior of the interbrachial region of the disc or of the mouth-parts. The drawing given (Text-fig. 65) shows that some ventro-lateralia were present, but their exact arrangement cannot be made out. The mouth-angle plates appear to have been large and prominent as in *U. kinahani*.

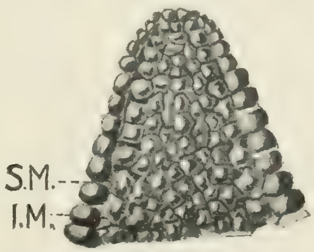
Measurements.—L. 11037 with its counterpart has approximately R : r : : 11 mm. : 4 mm. L. 11038 with its counterpart is slightly larger.

Horizon and Locality.—Hicks supposed that the beds from which these specimens were obtained were of Tremadoc (Upper Cambrian) age. Prof. O. T. Jones, however, in a letter to me, states: "The Ramsey Island Tremadoc beds have been shown by Mr. J. Pringle ('Geol. Mag.,' 1911, pp. 556—9) to be in all

probability Lower Arenig. This is based on the identification in them of *Calymene tristani* and *Ogygia selwyni*, both characteristic Lower Arenig forms. In their rather distorted state Hicks believed them to be *Nesuretus* and *Niobe* respectively. . . . There are probably no Tremadoc beds anywhere in the St. David's district, the Arenig beds being either faulted against Lingula Flags or older rocks, or lying unconformably upon them." This determines the horizon of the species to be Lower Ordovician, but even with the newer age of the form established, *U. ramseyensis* is the oldest known Asterozoan.

American Forms of Uranasteridæ.

It has already been pointed out (pp. 105, 106) that the American form *Petraster speciosus* is very similar to the English species of *Uranaster*. Schuchert has given a very full description of the form (85, pp. 142—145), to which the reader is referred. One of his illustrations is reproduced here (Text-fig. 67).



TEXT-FIG. 67.—A portion of the apical surface of *Petraster speciosus* to show the stellate supero-marginalia just inside the bordering infero-marginalia (reproduced from Schuchert). × 2·5.

It is clear from Schuchert's description that *P. speciosus* is descended from a slender-rayed form very similar to a *Uranaster*. It might be argued that since *P. speciosus* is from the Upper Ordovician and that *U. ramseyensis* and *U. kinahani* are from the Lower and Middle Ordovician respectively, *P. speciosus* might be a descendant of the English forms of *Uranaster*. Personally I am not inclined to take this view, for the appearance of the distal region of the arm is dissimilar in *P. speciosus* from that in the two species of *Uranaster*. None of the characteristic half-moon-shaped plates are present in the American species. Further, the mouth-angle plates in *Uranaster* are relatively larger than in *P. speciosus*. Rather does it seem that *Uranaster* and *P. speciosus* have descended from a common stock which has undergone slightly different changes in the two regions.

The type species of *Petraster* is *P. rugosus*, Billings, but unfortunately it is so little known that we cannot argue as to its exact relationships. I originally intended to make generic comparisons between *Uranaster* and *Petraster*, but until more is known of the type species of *Petraster* this appears to be useless. The species described by Schuchert as *Petraster ? americanus* (D'Orbigny) does not appear to be related to either *P. speciosus* or *P. rugosus* (see p. 125).

Australian Forms of Uranasteridæ.

Petraster smythi has been described by McCoy (95, p. 41, pl. x, figs. 1*a*, 1*b*). Schuchert remarks (85, p. 148): "So far as one can judge of the description and illustration, the species is a small but genuine *Petraster*." It is probable that Schuchert is right, but before the affinities of the form can definitely be decided, it will be necessary to undertake its further study. The species is stated to be very rare in the fine sandy Upper Silurian rocks of Moonee Ponds, Flemington, a little north of Melbourne.

Section B.—Family Lepidactinidæ, nova.

1899.	*Lepidasteridæ*	(pars), Gregory, Geol. Mag., dec. iv, vol. vi, p. 352 (see also p. 47 of this Monograph).
1900.	,,	(pars), Gregory, Lankester's Treat. Zool., vol. 3, Echinoderma, p. 255.
1914.	,,	(pars), Gregory (emend. Schuchert), Fossilium Catalogus, Animalia, pt. 3, p. 7.
1915.	,,	(pars), Gregory (emend. Schuchert), Bull. 88, U.S. Nat. Mus., p. 157.

Asterozoa with broad adambulacralia occupying almost the whole of the oral surface throughout the greater part of the arm. Surface of adambulacralia in the distal two-thirds of the arm evenly rounded and ornamented with stout short spines. Proximal adambulacralia modified. Infero-marginalia and radialia recognisable. Mouth-angle plates very prominent. Madreporite very large and oral in position.

All the English forms are from one locality and horizon, the Wenlock (Middle Silurian) Limestone of Dudley. One does not seem to have any really good clue to their ancestry, but they appear in many respects to be more closely related to the Asteroidea of Section A than to any of the other Asterozoan branches. The most primitive genus, *Lepidactis*, has much the same structure as early "*Mesopalæasters*," except that (1) the adambulacralia are broader and more convex, and (2) the very large madreporite is oral in position. The Family contains two genera:

Lepidactis, nov. gen., primitive five-rayed forms having distinctly differentiated radialia, supero- and infero-marginalia. There is one species, *L. wenlocki*, n. sp.

Lepidaster, Forbes, modified multi-armed forms. Extra apical plates are added, and the radialia and marginalia lose much of their differentiation. There is one species, *L. grayi*, Forbes.

Lepidaster has one very distinctive feature. The proximal insertions of the inter-adambulacral muscles were placed in round small deep holes near the oral surface and are very distinctive if the ossicles have been slightly displaced (Pl. VII, fig. 2). Unfortunately the conditions of preservation of *Lepidactis* do not allow me to be sure of the same type of muscle-insertion there. If it were it would make a really good Family-character.

Genus **LEPIDACTIS**, novum.

Generic Characters.—Arms five, petaloid. Adambulacralia wide, nearly all similar. Mouth-angle plates large with distinct odontophor. Distinct rows of supero- and infero-marginalia and radialia.

This genus is from the Wenlock Limestone of Dudley—the same horizon and locality as *Lepidaster grayi.* It shows a great general resemblance to *Lepidaster* in the shape and disposition of its adambulacralia and mouth-parts and in the position of its madreporite. The five arms and the structure of the marginalia show it, although contemporaneous, to be of a more primitive type. The shape of the madreporite and other points noticed in the description, suggest that it does not belong to the same lineage as *Lepidaster*, but rather to another offshoot. It is also interesting to note that the structure of the axillary oral region and of the apical surface is parallel to that shown in early "*Mesopalæaster*" stages of the Asteroidea dealt with in Section A of this Monograph.

The genotype and only species is *Lepidactis wenlocki.*

1. **Lepidactis wenlocki,** nov. sp. Plate VI, fig. 5; Text-figs. 68—70.

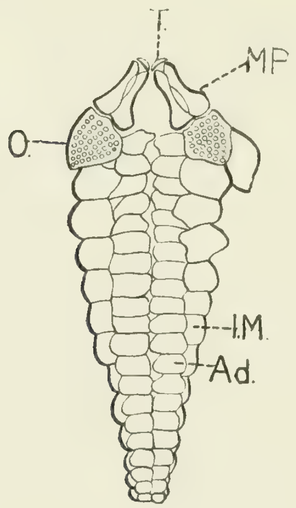
Material.—Only one specimen, preserved in the British Museum (Nat. Hist.) and registered as 57426. Originally only the oral surface was exposed, but I have been able to lay bare also the apical surface of the greater portion of one arm. Unfortunately the ossicles have been much disturbed before entombment, especially in the mouth-region. The specimen when found was cracked across the middle and put together again. These disturbances add considerably to the difficulties of study.

Oral Surface (Plate VI, fig. 5; Text-figs. 68, 69).—The specimen may be orientated from the position of the madreporite (M. of Pl. VI, fig. 5). The arms on each side of the madreporite are regarded as numbered I and II, and the numbering is continued in a counter-clockwise direction. The best reconstruction of the arm can be made from arm III and the neighbouring right interradius (Text-fig. 68). This interradius is occupied by two large infero-marginalia and an odontophor. The latter plate is completely shut off from the margin, and the axillary structure is consequently strongly reminiscent of the early "*Mesopalæaster*" stage of the Family Promopalæasteridæ (compare Text-fig. 41, p. 82). The odontophor on the left side of the arm is not shut off from the margin, but here the plate has obviously been much displaced and has one of its bordering infero-marginalia missing. This odontophor has the whole of its flat shield-shaped surface exposed. The proximal extremity is sharply pointed, the point doubtless fitting into the concavity between the two mouth-angle plates. On each side of the median point

there is a deep notch which served for the attachment of the distal end of a mouth-angle plate. Beyond the notch is the flat side for the articulation of the first adambulacral. Five spine-bearing ridges run fanwise along the ossicle. The spines have vanished, but their articular elevations may be seen. The sides of the odontophor, which fits on to the neighbouring infero-marginalia, are very straight.

The proximal infero-marginalia are very prominent plates with surfaces usually not uniformly swollen but ornamented by large irregular excrescences. Thus the first infero-marginal on the left side of the arm has a prominent irregular ridge on its oral surface, and the second and third show large mammillate inner projections. The first infero-marginal on the right side has a flat surface, but the second

68



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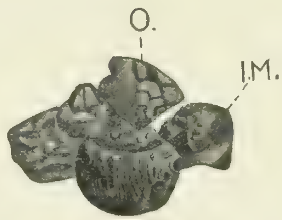


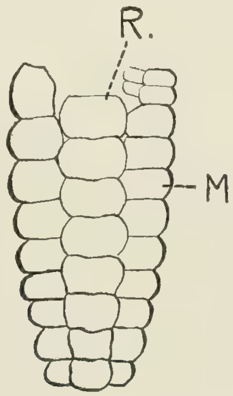
Text-fig. 68.—Plan of the ossicles on the oral surface of *Lepidactis wenlocki*. *Ad.*, adambulacralia; *I.M.*, infero-marginalia; *M.P.*, mouth-angle plates; *O.*, odontophor; *T.*, torus. × 3.
Text-fig. 69.—Wash drawing of the madreporite, odontophor (*O.*), and three infero-marginalia (*I.M.*) of *Lepidactis wenlocki*. × 6.

and third ossicles are as on the left side. The infero-marginalia distal to these form only a slight boundary to the oral surface, although a lateral view of the arm shows that they are well developed. Their surface is uniformly swollen and ornamented by pustules. Thirteen infero-marginalia have been counted in all, but the extremity of the arm is not entirely exposed.

Except in the proximal region, the greater portion of the width of the oral surface is occupied by the adambulacralia. These differ somewhat in shape in the various regions. About the middle of the arm they appear as oblong plates with a uniform highly convex surface. Their inner nose-end is not visible, as the groove is quite closed over. If the groove is slightly open, as it is in portions of arm IV, the pointed nose is distinctly visible as figured for *L. grayi*. There appears to have been a pustular closely-set ornament. The comb-spines have become

detached, but the short groove-spines may often still be seen on each side of the groove. The anterior depressions for the muscle-attachments may also be seen on a few of the ossicles on this same arm. They are not very distinct, but seem to have been confined to the inner oral side of the ossicle exactly as in *Lepidaster*, and not so deep as in that form.

The adambulacralia become smaller both proximally and distally from the median ossicles already described. The distal adambulacralia have the same shape and ornament as that already described. Proximally, however, the plates appear to become irregular in form. Unfortunately, owing to the disturbance already referred to, their exact shape and disposition are difficult to make out. Some of the outlines presented are given in Text-fig. 68. This same disturbance does not allow recognition of the mouth-parts *in situ*. A displaced mouth-angle plate lies near



TEXT-FIG. 70.—Plan of the ossicles on a portion of the apical surface of *Lepidactis wenlocki*. *R.*, radialia ; *M.*, supero-marginalia. × 3.

the madreporite, and it is very similar to that figured for *Lepidaster*. A few thin odontophors with spines still attached may also be seen in the central disc region.

The madreporite is a very large swollen plate lying at present entirely on the oral surface. There has been considerable disturbance in the interradius where it is situated, and it may originally have been somewhat oro-marginal in position. It is figured together with its surrounding plates in Text-fig. 69. It lies on the outer side of three plates, the odontophor and the proximal infero-marginalia, and is separated from the odontophor by a fourth small plate. Its outer edges are rounded, its proximal edge concave and distal edge convex. The madreporiform markings are raised and remind one in their appearance of some of the "chain corals." Generally, except in position, the plate is very dissimilar from that observed in *Lepidaster*.

Side View.—A lateral view of arm IV shows that the supero- and inferomarginalia are almost opposite. Two intermarginalia are seen. The larger proximal intermarginal is curious, inasmuch as it appears simply to stick on the

side of the marginalia and does not separate them. The distal intermarginal is a small triangular plate in an angle between two supero-marginalia. A few small apical plates may be seen in the axils of the arms, but there is no conspicuous interbrachial area.

Apical Surface (Text-fig. 70).—The figure given is a plan of the ossicles of the apical surface of arm IV. It will be noticed that the restoration does not include much of the disc region. I was unable to clear this region, as the fossil showed that it might break up. The portion of the arm exposed is very like that of "*Hudsonaster*." There is a row of stout radialia bordered on each side by supero-marginalia. The latter ossicles are alternate with the radialia in the proximal portion of the arm and come to lie opposite to them in the distal region. A few small adradialia enter the base of the arm just as they do in the early Mesopalæasterinæ (see p. 78). A suggestion that the form is reaching an advanced lineage stage is conveyed by the pronounced lack of symmetry of the proximal supero-marginalia, that on the left side being stout while that on the right is broken up into smaller ossicles. The under-surface of one of the disc-plates lies partially exposed in the interradius between arms IV and V. Its appearance is almost exactly similar to that of the under-side of one of the disc ossicles of *Calliasterella mira*, Trautschold, figured by Schöndorf (65, pl. xxiv, fig. 1*b*).

The ornament on the radialia and supero-marginalia is pustular like that on the infero-marginalia.

Measurements.—R : r : : 24 mm. : 7 mm. Width of arm at base is 8 mm.

Horizon and Locality.—Middle Silurian (Wenlock Limestone) of Dudley, Worcestershire.

Genus **LEPIDASTER**, Forbes.

1850. *Lepidaster*, Forbes, British Organic Remains (Mem. Geol. Surv.), dec. iii, p. 1.

Generic Characters.—Multiradiate. Proximal adambulacralia profoundly modified. Marginalia and the apical plates tend to lose their differentiation and to resemble each other.

1. **Lepidaster grayi**, Forbes. Plate VI, fig. 6; Plate VII, figs. 1—6; Text-figs. 71—78.

1850. *Lepidaster grayi*, Forbes, British Organic Remains (Mem. Geol. Surv.), dec. iii, p. 1, pl. i, figs. 1–3.
1862. „ Wright, British Foss. Echinodermata, Oolitic, vol. ii (Palæont. Soc. for 1861), p. 35.
? 1873. *Trichotaster plumiformis*, Wright, Quart. Journ. Geol. Soc., vol. xxix, p. 421.
1874. *Lepidaster grayi*, H. Woodward, Geol. Mag., dec. ii, vol. i, p. 9.
1879. „ *grayi*, Zittel, Handb. Palæont., vol. i, p. 454.
1890. „ *grayi*, Stürtz, Palæontographica, vol. xxxvi, p. 222, pl. xxviii, figs. 19–20.

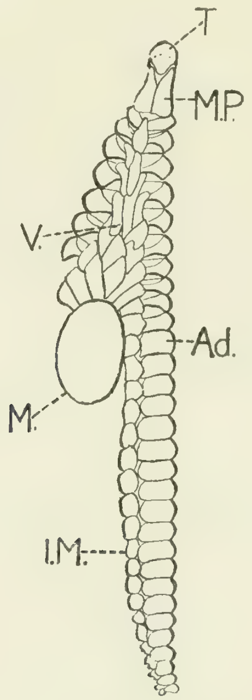
1893. *Lepidaster grayi*, Stürtz, Verhandl. nat. Ver. preuss. Rheinl., vol. l, pp. 52–72.
1914. „ *grayi*, Schuchert, Fossilium Catalogus, Animalia, pt. 3, pp. 5, 7, 22, 23.
1915. „ *grayi*, Schuchert, Bull. 88, U.S. Nat. Mus., pp. 38, 40, 158—160.

Material.—Five specimens of the species are known. The holotype figured by Forbes is in the British Museum (Nat. Hist.) and is registered as 40215. A smaller but much better preserved specimen is in the collection of the Museum of Practical Geology, Jermyn Street. The third specimen is in the Dudley Museum (No. 606), and the fourth in the Sedgwick Museum, Cambridge (*a* 717). A small specimen, which I believe to be a young immature form of the species, is in the Ketley Collection of the University of Birmingham.

The Holotype.—This has been excellently figured by Forbes, who describes the disc as " unfortunately so injured that its elements cannot be made out, but appears to have had a framework composed of closely-set polygonal ossicles." It is, as Forbes says, very difficult to make out any arrangement of the ossicles of the disc, but this may be due to secondary modifications due to the old age of this large specimen. The structure of the free portions of the arm is as in the Jermyn Street specimen. There is one point, however, which deserves special mention. Forbes describes " small polygonal intervening plates " which cover the ambulacral groove between the adambulacralia. These, if present, would be comparable to the ventral shields of the Ophiuroidea. Stürtz suggests that these plates are really separated ambulacralia, a conclusion supported by Schuchert (85, p. 159). There is no doubt that the plates look suspiciously like extra subambulacral pieces, as they are so regularly polygonal; and I have not been able to dissect downwards, without spoiling the specimen, to determine their true character. In view of the fact that they are not present in any of the other specimens, one must support Stürtz's conclusion. The madreporite is plainly figured but it appears to have escaped textual notice by all observers.

The Jermyn Street Specimen (Plate VII, figs. 1—5; Text-figs. 71, 72).—There are thirteen arms, orientated for the purpose of description by means of the madreporite which is situate in the interradius between the arms regarded as I and II. This interradius is well preserved and is drawn together with the bordering ossicles as Text-fig. 71. The main series of ossicles can readily be identified. The mouth-angle plates are large ossicles fitted with an exceptionally stout torus. The adambulacralia of the arms are wide and oblong, occupying the major portion of the oral surface and distally also assisting in forming the margin. Proximally they are considerably modified, a prominent transverse ridge being especially noticeable. The infero-marginalia in the axils of the arm are long and flat. When they pass on to the arms they become rounded and globular. There is also a large triangular interradial area filled in by numerous flat plates (ventro-lateralia) which separate the adambulacralia of neighbouring radii. A large madreporite is in the axil of the arm just exterior to the infero-marginalia.

Arms XI and XII give the best view of the large and subtriangular mouth-angle plates (Pl. VII, fig. 3). The interradial side of the triangle is thick and looks like a stout bar. It lies parallel with and adjoining the corresponding bar of the neighbouring mouth-angle plate. The proximal side of this pair of bars is excavated so as to form a deep hollow bordered by a thick lip. The torus fits against the lip. Rows of spine-pits run across the torus. The spines themselves have usually fallen away, but a few of them may be seen in the interradius containing the madreporite. The inner side of each mouth-angle plate is hollowed out very much as is the jaw of *Lapworthura* (compare with Pl. I, fig. 10). It is



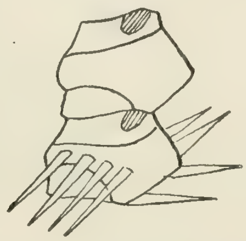
Text-fig. 71.—Plan of the ossicles on the oral surface of *Lepidaster grayi*. *Ad.*, adambulacralia; *I.M.*, infero-marginalia; *M.*, madreporite; *M.P.*, mouth-angle plates; *T.*, torus; *V.*, ventro-lateralia. × 3.

not possible to see the articulation of the first ambulacralia with the mouth-angle plates.

The adambulacralia in the proximal third of the arm are somewhat smaller than those immediately distal to the disc, and are considerably modified. A wash drawing is given (Pl. VII, fig. 2), which shows the modifications assumed by the adambulacralia. The three proximal adambulacralia of the figure each show a distinct nose on their inner side. This inner nose end is considerably thickened, and the thickening extends as a gradually thinning ridge across the ossicle. The fourth and fifth adambulacralia are turned somewhat on one side, but they show that the ridge meets a corresponding projection from a neighbouring infero-marginal. As we follow the adambulacralia distalwards the cross-ridge widens

gradually until, when we reach the adambulacralia situate a short distance away from the base of the arm, the whole surface of the ossicle is uniformly swollen. Owing to the displacement of the sixth to the eleventh adambulacralia this is not well seen in the figure. The most distal (the eleventh) adambulacral alone shows an evenly swollen surface. Further details as to the structure of these proximal adambulacralia may be gathered from the study of other portions of the specimen. The armature of spines is preserved on certain ossicles and figured (Text-fig. 72). It is seen that the nose end of the adambulacral carried spines which stretched across the groove. Stout spines were also carried on the transverse ridge.

The displaced adambulacralia mentioned above show the position and form of the inter-adambulacral muscles. The proximal articulation is situate upon a slightly projecting ridge placed at the inner edge of the ossicle. In consequence of the upward tilt of the articulating surface one can look well down into the muscle-excavation. The ridge in its natural position fits a backward projection



TEXT-FIG. 72.—Outline drawing of two proximal adambulacralia of *Lepidaster grayi*, to show the spines on the ridge. × 8.

from the preceding adambulacral, and under this projection is the excavation for the proximal extremity of the same muscle. The small deep hollows for the inter-adambulacral muscles are confined to the inner ends of the ossicles throughout the greater part of the arm. They present a very characteristic appearance. At the distal extremity they disappear, and then there is a weak concavity covering the whole of the articulating surface.

A side view of a displaced proximal adambulacral is figured (Pl. VII, fig. 4). The outwardly projecting knob articulated with a ventro-laterale. The proximal ambulacralia are figured (Pl. VII, fig. 2). They are flat plates with forwardly projecting pegs which fit into sockets on the preceding plates. A ridge for the separation of the tube-feet is present, but it is very thin and low, suggesting that the tube-feet are much reduced in functional importance. The distal ambulacralia are exposed in arm IV. These are oblong evenly swollen ossicles, and so far as I can see show no trace of a transverse ridge. Their inner end is somewhat swollen, but there is no trace of a concavity for the insertion of ventral cross-muscles. Obviously the articulation with the opposing ambulacralia was very loose, which may account for the easy displacement of these ossicles (see below).

Ambulacralia with but slight or no carination are described by Schuchert for *Hudsonaster narrawayi* (1915, p. 59) and *Anorthaster miamiensis* (1915, p. 126). Reduced adambulacralia are found in *Urasterella* (see below, p. 148) and *Calliasterella* (p. 167). It is obvious that a reduction of the ambulacralia in functional importance can occur in many different genera.

The infero-marginalia at the extremities of the arm are globular and swollen. Their disposition with respect to the ambulacralia varies in the different arms. Thus at the end of arm IV the infero-marginalia are equal in number and opposite to the ambulacralia. In arm X the distal infero-marginalia are slightly less numerous than the adambulacralia and consequently alternating (roughly there are four adambulacralia to three infero-marginalia). The infero-marginalia of this portion of the arm are on the lateral rather than the oral surface, but as we approach the base of the arm the infero-marginalia become flat and closely fitting. They also pass over on to the oral surface. They are always equal in number to

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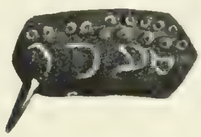

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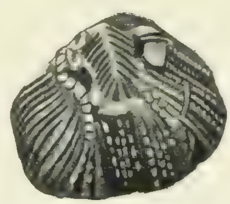

TEXT-FIG. 73.—Wash drawing of an adambulacral of *Lepidaster grayi* to show ornament. × 12.
TEXT-FIG. 74.—Wash drawing of the madreporite of *Lepidaster grayi*. × 6.

the adambulacralia, and each infero-marginal articulates with an adambulacral exactly as do the ventro-lateralia with the proximal adambulacralia (see above). The infero-marginalia at the exact base of the arm are squamiform. In the interradius between arms V and VI they are continued as an arc round the axil of the arm, but in the madreporite and other interradii they are more broken up and there is an appearance as if they were trying to thrust themselves into the disc. Displaced squamiform supero-marginalia may be seen in the interradii between several arms (see also below).

The Sedgwick Museum Specimen is incomplete. The appearance of the arms which have been preserved is much as in the Jermyn Street specimen.

The Dudley Specimen (Plate VII, fig. 6; Text-figs. 73, 74).—This specimen is almost exactly the size of the holotype. The disc was folded before preservation in such a way that an oral view of eight arms is obtained, the remaining arms being mostly in apical view. Although this allows valuable apical views not seen in other specimens, the disc is so effectively hidden that only the free portions of the arms may be observed. Their structure is exactly as in the Jermyn Street specimen. The whole surface of the form is pitted just as if originally it were

covered with spines. The fact, however, that these pits extend over the articulatory surfaces of the adambulacralia shows that they are secondary and due to weathering. Portions of the unweathered surfaces of a few of the adambulacralia, *e. g.* those on arm XIII figured, show raised pustules which carried stout spines (Text-fig. 73). The ornament on the madreporite is well preserved and figured (Text-fig. 74).

Birmingham University Specimen (Plate VI, fig. 6; Text-figs. 75, 76).—This is a small form which I believe to be an immature individual of the species. The specimen is fairly well preserved, except that the right-hand portion of the disc (as photographed) has been pushed over the left. In consequence it is difficult to count the arms. These numbered at least eight, and possibly ten, but I am sure there were not the normal thirteen arms present. This is not surprising if we

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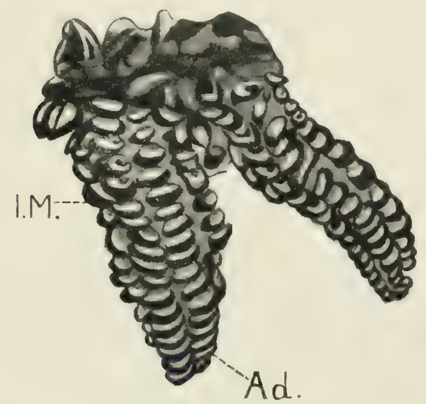

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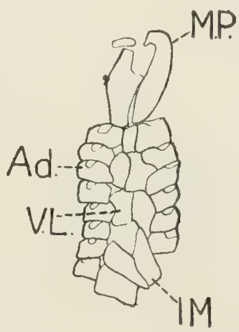


TEXT-FIG. 75.—Wash drawing of two arms of a young individual of *Lepidaster grayi*. *Ad.*, adradialia; *I.M.*, infero-marginalia. × 4.

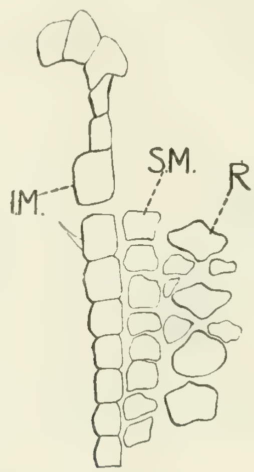
TEXT-FIG. 76.—Plan of ossicles of a portion of the oral surface of a young individual of *Lepidaster grayi*. *Ad.*, adambulacralia; *I.M.*, infero-marginalia; *M.P.*, mouth-angle plates; *V.L.*, ventro-lateralia. × 6.

remember that in certain Recent species arms are added until far in adult life (see Schuchert, 85, pp. 207—209). Only the oral surface is shown. The disc does not appear to have so many ventro-lateralia as in the previously described specimens. The proximal adambulacralia also appear to have been but slightly, if at all, modified. This latter is the only really distinctive character of the specimen which might entitle it to rank as a distinct species. It might well, however, be merely a sign of immaturity.

Apical Surface.—Forbes states that " Mr. Gray has dissected from the slab the extremity of one of the rays in such a manner as to permit an examination of both upper and under surfaces of the same ray." This upper surface was figured and described as " composed of numerous small polygonal nearly flat ossicula, closely set, and of various sizes." Stürtz copied this figure to try and establish the relationships of *Lepidaster* with the Recent *Scythaster*. Schuchert remarks (p. 158) that " Forbes's illustration leads the writer to believe that the abactinal plates

have been damaged and that originally the larger pieces were arranged in supra marginal columns, while the smaller ones composed the radial row of ossicula."

Unfortunately the original exposed apical piece has been lost; I have, however, exposed the end of an arm of the Jermyn Street specimen and obtained exactly the same arrangement as in Forbes's figure. The extremity of a "bent-over" arm of the Dudley specimen is similar, but a more proximal portion of the same arm showed a distinctly regular structure (Text-fig. 77), proving that *Lepidaster* is descended from a form with regularly arranged apical plates. Any irregular arrangement of the ossicles is probably not due to post-mortem derangement but to secondary changes of a similar type to those observed in *Promopalæaster* (p. 94) and *Mesopalæaster ketleyi* (p. 103). This view is supported by



Text-fig. 77.—Plan of a portion of the apical surface of *Lepidaster grayi* (from the Birmingham University Museum). *I.M.*, infero-marginalia; *R.*, radialia; *S.M.*, supero-marginalia? × 3.

the text-figure, which shows that the breast-plate-shaped radialia are not always closely touching but are separated occasionally by smaller plates—exactly the stage figured for *Promopalæaster elizæ* (Text-fig. 52, p. 93). The changes are so pronounced at the extremities of the arms that no regular arrangement is discernible. The Dudley specimen also shows that the apical plates at the base of the arm and those entering the disc are overlapping and very difficult to distinguish from one another. In this respect they compare with the disc-ossicles of the oral surface of the holotype, and may also represent a "senile" characteristic.

Cross-Section (Text-fig. 78).—Arm XIII of the Jermyn Street specimen gives a good view of a cross-section near the distal extremity. The large adambulacralia and want of symmetry of the apical plates are noticeable, as also the reduced ambulacralia. The figure should be compared with the cross-section of the arm of a *Urasterella* given (Text-fig. 93, p. 148). In both cases it is very obvious that the arm-cavity is much reduced.

Measurements.—The holotype has R : r : : 51 mm. : 22 mm. (R = 2.3 r). Length of free portion of arm is 27 mm.

Dudley Museum specimen: Length of free portion of arm is 27 mm.

Jermyn Street specimen has R : r : : 34 mm. : 14 mm. (R = 2·4 r). Length of free portion of arm is 20 mm.

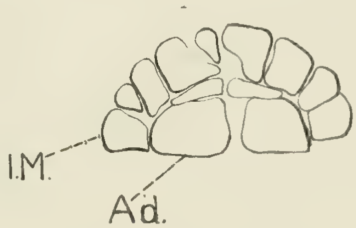
Sedgwick Museum specimen, R : r : : 23·2 mm. : 9·3 mm. (R = 2·5 r).

Birmingham University specimen, R : r : : 14·5 mm : 5·5 mm. (R = 2·6 r).

There is evidence, therefore, that the disc increases more rapidly than the arms as the form becomes more mature.

Horizon and Locality.—Middle Silurian (Wenlock Limestone) of Dudley, Worcestershire.

Trichotaster plumiformis.—The Grindrod Collection is stated by Wright to have contained a small ten-armed form from the same locality and horizon, which he named *Trichotaster plumiformis.* The specimen appears to have been very badly



TEXT-FIG. 78.—Cross-section through an arm of the Jermyn Street specimen of *Lepidaster grayi.* *Ad.*, adambulacralia; *I.M.*, infero-marginalia. × 6.

preserved, and it was not figured, but the original description is as follows: "The specimen described showed the outlines of a small starfish, with a large disc and short rays, in a slab of Wenlock Limestone from Dudley. The outline of the ten rays was described as marked out by the border of small triangular spines, the other plates of the disc and rays being absent. Each ray was terminated by a stem-like multi-articulate process as long as the ray, from towards the extremity of which spring slender lateral processes, giving it a tufted appearance." I have not seen the specimen, but the locality in which the specimen was found, and the fact that *Lepidaster* is the only pre-Devonian multi-rayed starfish, suggest that Wright's species, like the Birmingham University specimen, is an immature example of *Lepidaster grayi.*

Mode of Life of Lepidaster.

Some time ago, when thinking over the structure of *Lepidaster*, I came to the conclusion that it was not a predatory form like most of the Asteroidea, but that it was sedentary and sat with its apical surface on the sea floor whilst its arms were

bent upwards in order to capture food. The reasons which inclined me to this view were: (1) The specimens are always found with their apical surface downwards; (2) the strong interadambulacral muscles must have bent the arms upwards; (3) the tube-feet were obviously much reduced and could have been of little use for walking. Soon after I came to this conclusion, Dr. Gemmill sent me a paper on ciliary nutrition in certain species of Asteroidea (95, pp. 1—15) which confirmed me in my view and gave me a new stock of ideas. Gemmill found when investigating the actinal ciliation of the Recent pin-cushion starfish, *Porania pulvillus* (O. F. M.), "with the help of suspended particles, that there were periods during which extremely active ingestion of the particles through the mouth into the stomach occurred." He proceeded to give a list of structural or functional peculiarities which appeared to him to be direct adaptations for ciliary nutrition. There can be no doubt that Gemmill has proved his point, and that *Porania* can and does live in this way.

Many of the peculiarities mentioned by Gemmill cannot be tested in the dead *Lepidaster*, but there are certain characters of *Porania* which are parallel to those of our Silurian fossil. Thus, Gemmill notes (p. 11) that "the general shape of the starfish with its large flat intermediate [disc] areas, ensures that there is an extensive circumoral ciliated field, adapted for food-gathering purposes." The large disc of *Lepidaster* has already been noted, and it is perhaps significant that the measurements already given seem to show that the disc becomes relatively larger as the form grows older.

Again, Gemmill notes (p. 14) that the sucker feet of *Porania* "are neither particularly strong nor are they kept actively in use." This is exactly as we suspect to be the case in *Lepidaster*. Gemmill also makes an observation which suggests the use of the long spines of the odontophors of *Lepidaster*. He states (p. 13): "If the oral surface of a *Porania* be sharply irritated, the spines at the interradial angles of the mouth will close in and by interdigitating with each other will cover up the mouth-opening completely. In the same way the whole or any part of an ambulacral groove can be entirely shut in by the spines on opposite sides of the groove. We seem to have here a ready means of protecting the mouth from exposure to streams of inacceptable or injurious particles."

Lastly, it may be this peculiar mode of life of *Lepidaster* which has brought about the oral position of the madreporite. It would obviously have been useless functionally if it had been on the apical side pressed against the sea-bottom.

American Species of Lepidaster.

No English species are known which appear to be ancestral to any of the Lepidactidæ, although the direction of evolution from some form alike in several respects to *Mesopalæaster* is suggested by the structure of *L. wenlocki*. It is

possible, however, that the American Ordovician species named by Schuchert (85, p. 146) *Petraster? americanus*, D'Orbigny, may be an earlier relation.

This species is only known from a specimen which lies in the matrix in such a manner as to show the inner apical aspect of the ventral plates. It has a comparatively large disc, stout mouth-angle plates with large tori and adambulacralia described as "articulated together by little processes and corresponding sockets or sinuses." Neither drawing nor description gives sufficient detail to make the exact relationships of the form certain, but it seems possible that if the form were studied anew a more exact correspondence with *Lepidaster* would be found.

Section C.—Family Urasterellidæ, Schuchert;
,, Cnemidactinidæ, nova;
,, Protarthrasteridæ, nova.

In the Introductory Section to this Monograph I pointed out (*e.g.*, p. 52) that the Palæozoic Asterozoa include:

(1) Forms which are more or less strictly comparable to the Asteroidea and Ophiuroidea of the present day.

(2) Forms which really represent branches of the Asterozoan stock not represented by modern survivors.

The Families described in this section belong to an extinct branch stock at one time with a world-wide distribution and of great importance. They must have originated early because they form an important section of the earliest known Asterozoa. The classified list of characters given below shows that they had distinct Asteroid affinities masked frequently by the Ophiuroid (wriggling) mode of life which they assumed.

The following general characteristics of these Families may be enumerated:

(a) *Those which show the Relationships with the Asteroidea.*

(1) There is usually at least one row of marginalia.
(2) The madreporite is apical in position.
(3) The inter-adambulacral muscles have the same type of insertion as in many Recent Asteroidea.
(4) The ambulacralia are always "asteroid."

(b) *Special Characters.*

(1) The disc is small and the arms are very long in proportion (see Text-fig. 89, p. 139). This gives the forms a very "ophiuroid" appearance.
(2) The adambulacralia are stout plates usually covering the whole of the oral surface of the arm and frequently also assisting in forming the margin. Each almost always possesses a

prominent ridge upon which is frequently borne a row of stout spines. At first sight, especially when the groove is open, they might be mistaken for the side-shields of true "Ophiuroids." Really, however, they have quite a different structure (see below).

(3) All the plates of the apical surface have usually stout spine-like or ridge-like paxillar projections which carry spines.

(c) *Characters which show the Origin of the Families.*

(1) The early members of the lineages have an arrangement of the plates of the disc which is even more primitive than in the Hudsonasteridæ (see p. 129 and Text-fig. 81).

(2) Infero-marginalia can always be recognised, but there are no supero-marginalia. It will be remembered that the forms of Section A had always both series of marginalia, although it was suggested (p. 67) that the supero-marginalia had arisen later than the infero-marginalia. The fact that only infero-marginalia can be recognised in the form now about to be described, supports the argument from the structure of the apical plates, namely, that the Families broke away from the original stock before the typical "*Hudsonaster*" structure was developed. These infero-marginalia are pushed well over on to the apical surface by the strong development of the adambulacralia.

Distribution.—The forms are widely distributed both in space and time. They appear with the earliest known Asterozoa in the Ordovician, and comprise a fair proportion of the forms in the early Palæozoic rocks. In the Mesozoic they become relatively less important, although one genus, *Arthraster*, persists into the Chalk. Species have been recognised from the rocks of N. America, England, Scandinavia, Russia, Germany, and Australia.

Lineage Changes.—It will be noticed in the description below (p. 136) that the forms present lineage changes comparable to those shown by the Asteroidea of Section A (pp. 61—65).

Schuchert, as recently as 1914, appears to have been the first to recognise the essential similarity of structure of many of the various forms which are now about to be described. His super-family, the Urasterellacea (see above, p. 58), includes most of the species described below together with an additional family, that of the Compsasteridæ. Personally, however, I do not feel that I know enough about this latter family to undertake its classification for the moment.

Schuchert classifies the Urasterellacea among the Cryptozonate Asteroidea. Hudson, more recently still, has published a valuable paper in which he remarks that the structure of *Urasterella* shows that we have here a "new sub-class of

Asterozoa" (93, p. 119). Very generously he leaves me to name this sub-class I do not propose, however, to name any sub-class for the moment, but to await the further completion of my work before attempting a new classification—a task which at present I do not feel competent to undertake.

The Family Cnemidactinidæ is in the fundamental structure of the ambulacral groove the simplest of the group. Unfortunately, however, it is represented solely by one genus and one species, which, like the representatives of *Promopalæaster*, is found only at its maximum of elaboration just before its final extinction. The want of knowledge of all except this single form renders it desirable to choose the next simplest set of forms, the Urasterellidæ, for initial study.

Family URASTERELLIDÆ, Schuchert (emend.).

1899. *Tæniasteridæ*, Gregory (part), Geol. Mag., dec. iv, vol. vi, p. 351 (includes *Tæniaster*, *? Stenaster Urasterella*, *Protasteracanthion*, *Salteraster*).
1900. *Rœmerasterinæ*, Gregory, Lankester's Treat. Zool., vol. iii, Echinoderma, p. 255.
1914. *Urasterellidæ*, Schuchert (part), Fossilium Catalogus, Animalia, pt. 3, p. 7.
1915. „ Schuchert (part), Bull. 88, U.S. Nat. Mus., p. 172.

Diagnosis.—Group C forms with adambulacralia allowing of free movement of the arms. Adambulacral ornament usually specially prominent along a transverse ridge. Infero-marginalia with columnar paxilla-shafts. Apical surface of disc with paired interradialia (proximal adradialia) immediately distal to the primary circlet.

The family comprises two genera—*Urasterella*, McCoy, and *Salteraster*, Stürtz.

Schuchert's description of the forms within the Family constituted a great advance on all previous knowledge, for he not only clearly described the American forms but established clear relationships with English, German, Russian, and Australian representatives. His diagnosis is as follows: "Specialised Cryptozonia, with alternate ambulacra, and with adambulacral type of oral armature. Rays five, rather flexible, long and gently tapering, proximally united without forming interbrachial areas. No inframarginals discernible as such at maturity, the actinal margin being occupied by well-developed adambulacrals. Abactinal area composed of numerous small plates arranged in columns and quincunx. The radial and supra-marginal columns may be discernible in somewhat larger plates. Adambulacrals many, like coins set on edge. Contains: *Urasterella*, McCoy." Later knowledge compels the radical modification of this diagnosis.

General Appearance of the Urasterellidæ.—A good idea of the general appearance of the Urasterellidæ may be obtained from a study of the text-figures (p. 129, p. 139 and p. 167) and the photographs given (Pls. IX, X). The disc is seen to be small, while the arms are often very long. The length of the arm suggests a wriggling form of life, a conclusion borne out by the studies given below. The transition between the various lengths of the arms is shown in the

Plate. A cross-section through the arm shows even more clearly some of the essential differences between these forms and the Asteroidea of Section A, especially if the two sections be placed alongside as they are in Text-figs. 79, 80. It will be noticed that in *Promopalæaster* the adambulacralia are comparatively small, and the great mass of the calcareous skeleton consists of the marginalia and the apical plates, while in *Urasterella* the adambulacralia are remarkably stout and it is difficult to distinguish marginalia. Further the calcareous skeleton of *Promopalæaster* encloses a large body-cavity which helps to contain the viscera, gonads, etc. In *Urasterella* as we shall see (below, p. 130) there is distinct evidence that the viscera scarcely entered the body-cavity. Another important feature of the Urasterellidæ is the paxillar character of the apical and marginal plates. All these features are dealt with in detail below.

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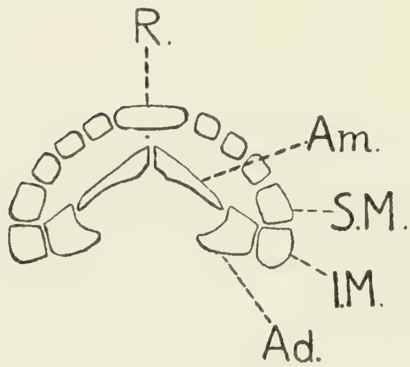

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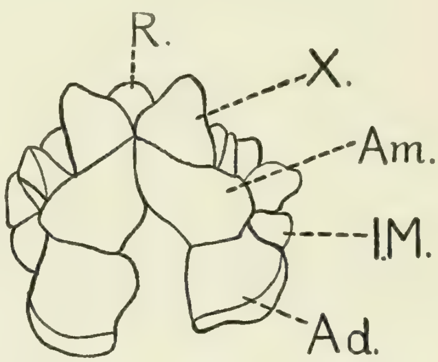
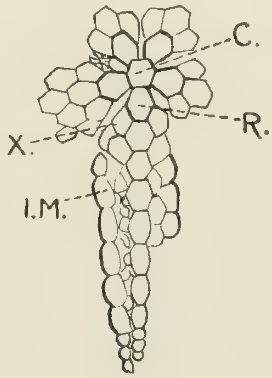


TEXT-FIG. 79.—Cross-section through an arm of *Promopalæaster elizæ* (slightly diagrammatised). *Ad.*, adambulacral; *Am.*, ambulacral; *I.M.*, infero-marginal; *R.*, radial; *S.M.*, supero-marginal. × 6.
TEXT-FIG. 80.—Cross-section of the arm of *Urasterella pulchella* (after Hudson). *Ad.*, adambulacral; *Am.*, ambulacral; *I.M.*, infero-marginal; *R.*, radial; *X.*, first adradial. Notice the first adradial on the right side fitting into a concave depression on the ambulacral. × 15.

Arrangement of the Apical Plates (Text-fig. 81; Text-fig. 88, p. 138; Text-fig. 92, p. 143).—A type of arrangement of the apical plates which may undoubtedly be regarded as primitive, is well shown in four English specimens (one adult *Urasterella thraivensis*, n. sp.; one young of same species; two adult *U. ruthveni*, var. *leintwardinensis*) and one American species, a young form of *U. ulrichi*, Schuchert (85, pl. 30, fig. 6). The centre of the disc is occupied by a centrale which may exceptionally appear as a double ossicle. External to this is a circle of six plates, five of which are in series with the radialia and are undoubtedly primary radialia, whilst the sixth is in the madreporic interradius just proximal to the madreporite and is a single primary interradial. It is clear that this arrangement is more primitive than that in the most primitive Asteroidea of Section A (the Hudsonasteridæ), for these have a centrale separated from the primary radialia by a ring of accessory plates and never possess less than five primary interradialia (see above, p. 61). Schuchert, in spite of his frequent

assertions that all the Asterozoa can be derived from *Hudsonaster*, makes the same point, for he states (85, p. 49) with respect to accessory disc-pieces: "In mature *Hudsonaster* they form a single ring, but in the young of the cryptozonian *Urasterella* (*U. ulrichi*) and in mature *Calliasterella* there are none of these accessory pieces present. For these reasons it is thought that in the Ordovicic there will be found a small asterid, even more primitive than *Hudsonaster*, that will be devoid of accessory disc pieces."

Some interesting correspondence with Dr. Gemmill enables me to cite the presence of a single primary interradial as evidence of the exceedingly primitive nature of the arrangement of the disc-ossicles. Two years ago I wrote to him and pointed out the seeming importance of the five large primary interradialia in the Hudsonasteridæ as being paralleled in the young stages of the Recent *Asterias*. In his reply he remarked: "The large regular interradials in the young *Asterias* are



TEXT-FIG. 81.—Plan of ossicles on the apical surface of a young individual of *Urasterella thraivensis* (D. 46). *C.*, centrale; *I.M.*, infero-marginalia; *R.*, radialia; *X.*, first adradial. × 10.

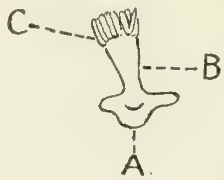
no doubt of much importance for purposes of comparison, but only, I should say, within forms of definite Asteroid or Ophiuroid type. These ossicles are, of course, as a series, results and not precursors of perfected quinqueradiate symmetry, and there is reason, I think, for considering that one of them (that in the madreporic interradius) is not strictly homologous with the rest" (see 94, p. 266). At that time I was not acquainted with the structure of *Urasterella*, and it is pleasant to observe that the structure of the genus substantiates his view, that originally the only interraidial present was that which throughout the whole of the Asteroidea is closely associated with the madreporite.

The remaining plates of the disc are figured as radialia, adradialia and infero-marginalia. This is not quite in accordance with the views of Schuchert, who regarded the Urasterellidæ as belonging to the "Cryptozonia," that is, to the Asteroidea in which, in the adult, the original marginal series can no longer be clearly distinguished from the remaining plates. He was only prepared to admit that he had been able to recognise infero-marginalia in the axillary regions of a

young form of *Urasterella ulrichi*, in *U. asperula* (85, p. 174), and at the distal (younger) end of the arm of an adult *U. pulchella* (85, p. 179). The supero-marginalia, he thought (85, p. 173), might be discernible in the two larger columns of plates which in some species run down the sides of the radialia (*X.* of Text-fig. 80, p. 128).

It seems to me that the various series are much more readily recognisable in the English than in the American species. At any rate, I have been always able to distinguish infero-marginalia from the remaining plates in both young and old specimens. Supero-marginalia are never present. The series called supero-marginalia by Schuchert are not present in *Salteraster* (Text-fig. 94, p. 150) and are clearly the first row of adradialia in *Urasterella.*

The fact that there are Asterozoa which possess clearly discernible infero-marginalia but no supero-marginalia is not surprising. Reasons were given above (pp. 76, 77) for the view that even in the case of those Asteroidea which possess a double marginal series, the infero-marginalia precede the supero-marginalia in



TEXT-FIG. 82.—Drawing illustrating the terms used in describing paxillæ. *A.*, paxilla-shaft; *B.*, paxilla-base; *C.*, paxilla-crown.

development. The Urasterellidæ are one of the groups of forms which separated from the original stock before supero-marginalia were developed, that is, they came from pre-*Hudsonaster* stock.

It will be seen that these conclusions are supported by a study of the Cnemidactinidæ (p. 155).

Hudson (93, p. 134) brings forward good evidence that the apical plates fit closely to the tops of the ambulacralia, and that we must conclude that in the American species the viscera did not extend into the arms beyond the second pair of ambulacralia. He shows, for example, in the cross-section reproduced (Text-fig. 80) that the first adradial fits into a curve at the top of the right ambulacral. It may be added that the reduction of the dorsal body-cavity seems to have taken place independently in several of the Asterozoan branches.

Hudson also suggests that the small channels visible between the ambulacralia and the infero-marginalia (photograph reproduced here, Pl. VIII, fig. 7) were for a "fringe of papulæ issuing between the infra-marginals and the covering plates" (93. p. 126).

Structure of the individual Apical Plates (Text-figs. 82, 92).—Schuchert noticed (85, p. 173) that a very distinctive feature of the Urasterellidæ was the tendency of

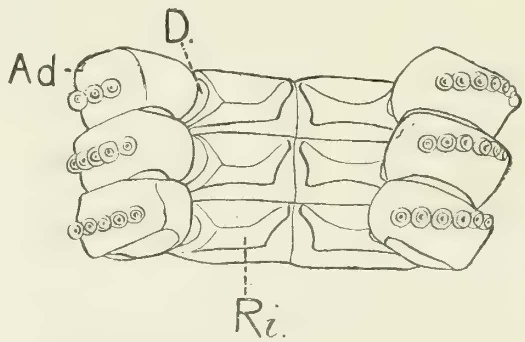
many of the apical plates to be "drawn out into more or less long, blunt, stout, erect, non-articulatory rods." Hudson has shown more recently that the rods carry small spines, and the plates are in fact paxillæ. It is convenient for descriptive purposes to adopt Ludwig's terms (40, p. 510) for the various parts of the paxilla, namely, paxilla-base, paxilla-shaft, and paxilla-crown. These terms are illustrated in Text-fig. 82.

One of Hudson's figures is reproduced here (Pl. VIII, fig. 7). Each paxilla according to Hudson, carries "three long articulated spinelets" (93, p. 130). He also shows that the paxilla-shafts (pedicels) and spinelets "are built of an alternating series of light and dark discs. The dark discs indicate the former presence of organic tissues, the white discs the presence of more open or spongy stereom formation. The writer would interpret this appearance as indicating that the spinelets were increased in length by a series of tissue extensions at the tips, these extensions becoming consecutive centres of stereom formation which, however, did not completely join one another. The spines seem also to have been formed in the same manner, and the whole structure is of a very primitive nature. Such a structure must not only have kept the spinelets from becoming very rigid bodies, but it must also have allowed them to fall apart, like a broken string of beads in decay . . . the pedicels also became separated from the plate-bases during decay and, like the spinelets, broke up into similar but more robust beads" (*op. cit.*, p. 131).

I have not been able to distinguish the spinelets in English forms, possibly because they so readily decay. The paxilla-shafts (pedicels) are, however, usually recognisable. In most species of *Urasterella* (Text-fig. 92, p. 143) the paxilla-shafts of the radialia and the first row of adradialia are ridge-like, the ridge running along the length of the ossicle, while the remaining adradialia have rod-like paxilla-shafts. In *Salteraster* (Text-fig. 94, p. 150) the paxilla-shafts of the radialia are usually boss-shaped, those of the adradialia rod-like. In *Urasterella montana* they are shaped like an inverted cone (Text-fig. 93, p. 148).

Structure of the Ambulacral Groove (Plate VIII, figs. 1—3; Text-figs. 83—85). —Many mis-statements have been made with respect to the structure of the ambulacral groove. Most of them have been corrected by Hudson (*op. cit.*), but it is still possible to add details to the facts already established. Some of these details allow one to obtain a more adequate picture of the mode of life of the forms. The material I have studied the most closely is that of *Urasterella thraivensis*, n. sp., several of the specimens of this species showing displaced isolated ossicles. It was found possible to make enlarged models of them in plasticine, which were later reproduced in plaster-of-Paris. A photograph of the more proximal portion of the ambulacral groove reconstructed in this way is given (Pl. VIII, fig. 1). The position of the ossicles is almost that which they would occupy if the groove were widely open. A lettered tracing of this photograph is given (Text-fig. 83).

The ambulacralia are stout, oblong, closely-fitting plates. Stout ┘-shaped ridges run across their oral faces and serve to separate the depressions for the tube-feet. Down the middle of the groove runs the ambulacral channel for the radial water-vascular and blood-vessels. The concave depressions between each of the opposing pairs of ossicles doubtless served for the attachment of the ventral cross-muscles. Primitive ambulacralia very much of this type are found in several of the Asterozoan branches and have already been described for *Promopalæaster* (Text-fig. 54 A, p. 95). An important character in the ambulacralia of *Urasterella* is the position of the depression for the muscles connecting the ambulacralia with the adambulacralia. The photograph given (Pl. VIII, fig. 2) shows that these articular depressions are situated well on the proximal face of the ambulacralia and shaped so that their median plane dips sharply towards the mouth. The effect is to make the oral surfaces of the adambulacralia also tip towards the mouth.



TEXT-FIG. 83.—Plan of the model of *Urasterella thraivensis* photographed Pl. VIII, fig. 1. *Ad.*, adambulacralia; *D.*, depression for the muscle between ambulacral and adambulacral; *Ri.*, ambulacral ridge. × 10.

The description of the ambulacralia of *U. pulchella* and *U. medusa* given by Hudson (93, pp. 123–127) agrees on the whole with this. He does not seem to have obtained clear oral views of the ambulacralia, but he has obtained, what I have not, excellent apical views. He shows that there is no room between the plates for the passage of ampullæ. This is shown in one of his photographs reproduced here, Pl. VIII, fig. 7. He also shows that the imbrication of the ambulacralia varies according to their position, that is, a few proximal ossicles slope towards the mouth, but the majority slope away from it (*op. cit.*, p. 123). In order to make this clear I have given a simple diagram (Text-fig. 84).

Schuchert (85, p. 172) describes the ambulacralia as being alternate. With respect to this Hudson remarks (*op. cit.*, p. 127): "The arrangement of the flooring plates in *U. medusa* is for the greater part an alternate one. Those oppositely placed being those of the peristomial ring and a few following them; arm A has nine plates oppositely placed, arm B but two pairs, and arm C apparently but one pair. In *U. pulchella*, however, in both holotype and plesiotype, the arrangement so far as seen is an opposite one. Only confusion can come from persisting in using this

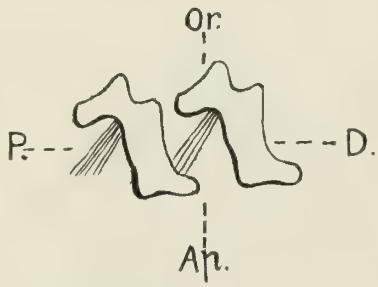
character, of alternate or opposite arrangement of floor-plates, in our definitions of genera or larger groups of palæozoic sea-stars. In *Blastoidocrinus*, the blastids, and all forms in which the growing arm-tip rests against the bibrachials, radials, or terminal plates, the flooring-plates are developed alternately. When one has become well grown and stiffened with stereom it takes up the thrusts against the growing arm-tip and leaves a space on the opposite side, practically free from compression, where the embryonic new plate and its concomitant structures may assume their proper positions. The subsequent arrangement of these plates is due to other factors, and they may be found alternately placed in one arm whilst oppositely placed in another of the same individual."

As the arm is followed distalwards the ambulacralia become much squarer in outline.

The adambulacralia are stout and high. Each has a small nose where it meets

84

85



TEXT-FIG. 84.—Drawing illustrating the change in the slope of the ambulacralia of *Urasterella thraivensis* as they proceed from the mouth-region (*P.*) distalwards (*D.*).

TEXT-FIG. 85.—Diagram illustrating the muscle-insertions on the proximal adambulacralia of *Urasterella thraivensis*. *Ap.*, apical surface; *Or.*, oral surface; *D.*, distal surface; *P.*, proximal surface.

an ambulacral. The oral faces have well-marked transverse ridges to which were attached long spines (Pl. VIII, fig. 3). The possession of the ridge and spines gives some resemblance to the side-shields of the Ophiuroidea. The resemblance, however, is superficial. The Ophiuroid side-shields are but loosely connected, the interadambulacral muscles being only slightly developed or absent. The Urasterellid adambulacralia have strong interadambulacral muscles, which appear to have played a similar part in wriggling movements to the ambulacral (vertebral) muscles of the Ophiuroidea. This is particularly well seen in the case of the adambulacralia near the base of the arms, which have distinct differentiation in their proximal and distal muscle-excavations leading to increased power of the muscle. The proximal excavation is on a forward projecting ridge situate just under the oral face, while the distal excavation is on a backwardly directed projection just above the nose. In consequence of the slope of the ossicles already referred to, the interadambulacral muscles must have run very much as in the diagram given (Text-fig. 85). The contraction of the muscle would tip the ossicles still more towards the mouth and so cause dorso-ventral flexions. Side flexions

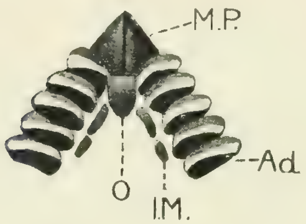
would be produced by the action of the muscles of one side only. The position of the arms of *Calliasterella*, figured Text-fig. 109, p. 167, shows that the arms of relations of *Urasterella* had considerable power of rolling up, and one cannot doubt this for *Urasterella* itself. Somewhat similar interadambulacral muscles may be found in recent Asteroidea. It is the large size of the adambulacralia in the Urasterellidæ which gives the muscles a special significance.

The two muscle-insertions of the adambulacralia appear to be more evenly hollowed from the middle of the arm to the distal extremity.

The inner adambulacral face is flat in the proximal region of the arm. Distalwards it is distinctly ridged. The ridges, as usual, helped to form the walls of the depressions for the tube-feet.

If the groove be open the inner face appears to form a knee-bend where it

86



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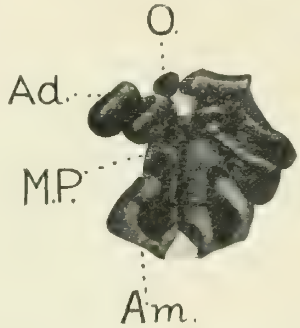


Text-fig. 86.—Wash drawing of an interradial angle of *Urasterella thraivensis*. *Ad.*, adambulacralia *I.M.*, infero-marginalia; *M.P.*, mouth-angle plates; *O.*, odontophor. × 4.

Text-fig. 87.—Wash drawing of an interradial angle of *Urasterella thraivensis* viewed from inside the mouth (adoralwards). *Ad.*, adambulacralia; *Am.*, first ambulacral; *M.P.*, mouth-angle plates; *O.*, odontophor. × 4.

joins the oral face (Pl. XI, fig. 8). Usually the groove is not found open, but almost if not completely closed. It is so figured in the reconstructions given (Text-figs. 89, 91, 95).

The crests of the adambulacral ridges are occupied by raised perforated pustules, to which doubtless stout spines were attached. No spines have been observed in this species, but they may be seen in *U. ruthveni* and *U. ruthveni*, var. *leintwardinensis*.

Hudson suggests (*op. cit.*, p. 134) that the adambulacral spines of *U. medusa* are " minute paxillæ, each pedical bearing two spinelets."

Structure of the Mouth-parts (Text-figs. 86, 87).—The mouth-parts are strikingly similar in both the English and the American species of the Urasterellidæ. Text-fig. 86 shows a view of the interradial angle of *U. thraivensis*. The mouth-angle plates are prominent and triangular flat ossicles in series with the crested adambulacralia. Immediately distal to and within the angle of the arm is the odontophor (the axillary interbrachial of Schuchert and Hudson). Behind this are outlined

the edges of four infero-marginalia. Text-fig. 87 shows a view of the mouth-parts of another arm of the same individual looked at from inside the mouth (adorally). The first ambulacral is a very stout plate with a median concavity bordered by two ridges. This same concavity is continued upwards into a hollow in the mouth-angle plate. It serves to house the first tube-foot. It will also be noticed that there are opposite to the first three ambulacralia shown, one mouth-angle plate and two adambulacralia, not one mouth-angle plate and three adambulacralia as is so frequently the case in the Asterozoa.

Hudson (93) has given a good photograph of the mouth-parts of the American species, *U. pulchella* (reproduced here, Pl. XI, fig. 7). He also kindly sent me a stereogram of the mouth-parts of this species showing a slightly different stage in his laying bare the structures to that he has figured. It shows essentially the same structures as those observed in the English species. Hudson noted (*op. cit.*, p. 123) the large first ambulacralia with their deep pit. He was inclined to regard the pit as serving "for an adductor which assisted in drawing inward the first or interradial pair of cover-plates" (p. 122). In a private letter to me, which enclosed the stereogram, he asks me to note "the paired muscle-remains (one of which is nearly lost) just within the large interradial [odontophor]." He goes on to state that there must have been muscles to draw in the mouth-angle plates, which in each interradius acted as an outer jaw. The origin of these adductors may have been on the inner surface of the odontophors rather than on the first ambulacralia. I see no reason for doubting these later conclusions of Hudson. As already has been pointed out, the pit on the first ambulacral is not a muscle-articulation but a depression for a tube-foot. On the other hand, the stout odontophor may well have served as a fulcrum for muscles moving the mouth-angle plates.

None of the English specimens show an apical view of the mouth-parts. Hudson, however, has obtained a good apical view of the mouth-parts of *U. medusa*. I have reproduced one of his photographs here (Pl. VIII, fig. 4) because it shows such a clear resemblance to the corresponding structure in *Cnemidactis* (Pl. VIII, fig. 5). One of the interesting features in *Cnemidactis* is the high odontophor, visible in the photograph as a rounded grooved plate immediately above the mouth-angle plates. The photograph of *U. medusa* shows that the odontophor is similar and equally important in the Urasterellidæ. One would not guess this, however, because it is vertical and almost always hidden by the apical plates. Schuchert in fact (85, p. 174) regarded the odontophor as being only present in the young forms. It obviously, as a rule, is difficult to see. Careful search shows, however, that it is always present.

Genus **URASTERELLA**, McCoy (emend.).

1855. *Urasterella*, McCoy, Brit. Palæoz. Foss., p. 59 (not defined).

1885. *Stenaster*, Billings (pars), Canadian Organ. Rem., iii, p. 77.

1868. *Urasterella*, Hall, 20th Rep. New York State Cab., p. 289 ; rev. ed., p. 332.
1874. „ McCoy, Prodr. Palæont. Victoria, i, p. 42.
1879. „ Zittel, Handb. Palæont., vol. i, p. 453.
1886. „ Stürtz, Neues Jahrb. für Miner., vol. ii, p. 152.
1886. *Rœmeraster*, Stürtz, Palæontographica, vol. xxxii, p. 85.
1890. *Urasterella*, Stürtz, *loc. cit.*, vol. xxxvi, p. 219.
1890. *Rœmeraster*, Stürtz, *loc. cit.*, vol. xxxvi, p. 220.
1893. *Stenaster*, Stürtz, Verh. Nat. Ver. preuss. Rheinl., Jahrg. 50, pp. 40, 56.
1893. *Rœmeraster*, Stürtz, *loc. cit.*, pp. 52, 73.
1899. *Urasterella*, Gregory (pars), Geol. Mag., dec. iv, vol. vi, p. 352.
1914. „ Schuchert, Fossilium Catalogus, Animalia, pt. 3, pp. 5, 7, 28, 36, 37, 39, 44.
1915. Schuchert (pars), Bull. 88, U.S. Nat. Mus., pp. 41, 42, 45, 47, 49, 50, 69, 164, 173, 194, 212.
1916. Hudson, G. H., New York State Mus. Bull., Twelfth Report of the Director, 1915, pp. 117—139.

A history of the genus is given by Schuchert (1915, pp. 175—177).

Generic Characters.—A Urasterellid with dissimilar rows of adradialia.

Species of Urasterella.

	British Isles.	America.	European Continent.
Middle Ordovician .	—	*U. pulchella* *U. medusa* *U. ulrichi*	—
Upper Ordovician .	*U. thraivensis*	—	—
Lower Silurian .	—	*U. ruthveni*, mut. *arisaigensis* (not described)	—
Middle Silurian .	*U. gutterfordensis*	—	*U. ruthveni*, var. *leintwardinensis.*
Upper Silurian .	*U. ruthveni*, var. *leintwardinensis* *U. ruthveni*	—	—
Devonian . .	—	*U. lutheri* (not described) *U. stella* (not described) *U. schucherti* (not described) *U.* nov. sp. (not described)	*U. asperula.*
Carboniferous .	—	—	*U. montana.*

There appear to be several lineages represented, and we cannot with our present knowledge separate them. We can take the following characters as showing progressive elaboration :

(1) An increase in size — Observed generally.

(2) A comparative lengthening of the arm — All young English and American forms are much more stellate than the more mature individuals.

(3) A breaking up of the continuity of the radial series	From comparison with changes in the Asteroidea of Section A.
(4) A loss of symmetry in the central plates of the disc	Ditto.

The increase in size may be observed in the lineage commencing in the Lower Ludlow *U. ruthveni*, var. *leintwardinensis;* and progressing through the stage *U. ruthveni;* until we reach *U. asperula* of the Devonian.

This same series shows a progressive increase in the comparative length of the arm. The same increase can be observed in individuals of *U. ruthveni* as they become more mature. *U. asperula* shows a loss of symmetry in the central plates of the disc. A breaking up of the continuity of the radial series is seen in *U. ulrichi.*

It is possible that the long-armed Upper Ordovician British species *U. thraivensis* may be descended from an American stellate form such as *U. pulchella.* It obviously represents a distinct lineage from that arrayed round the later more stellate Silurian *U. ruthveni*, although the distinctive characters are very minute.

1. **Urasterella thraivensis,** n. sp. Plate VIII, figs. 1—3; Plate IX, figs. 1, 2; Plate X, fig. 1; Text-figs. 81 (p. 129), 83—89.

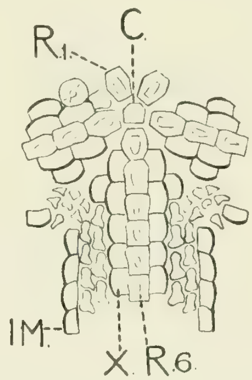
Material.—Six specimens are known, all moulds in sandstone, in Mrs. Gray's Collection from Thraive Glen. D. 111 shows the structure of the apical surface of the disc and portions of three arms; D. 35 and its counterpart give rather distorted views of the disc and proximal portions of three arms; D. 254 shows excellent views of the mouth-parts and of the oral side of the arm; D. 230 and D. 237, and their counterparts, enable one to obtain very various views of isolated plates as their component ossicles have been considerably displaced and scattered. D. 46 with its counterpart is probably a young form of the species.

Specific Characters.—Ridges on adambulacralia set well in the middle of the oral surface.

Apical Surface (Plate IX, fig. 1; Text-fig. 88).—The structure of the central portion of the disc and of the arms can very well be made out in casts from D. 111. A plan of the ossicles is given (Text-fig. 88). The general arrangement of the plates has already been referred to (p. 129). The quinque-radiate symmetry of the disc is very striking. There is a centrale surrounded by five primary radialia. Each of these is a prominent plate with a distinct longitudinal ridge. Only one interradial is present, namely, that in the madreporic interradius. The madreporite is quite small, distinctly smaller than a primary radial. The remaining radialia are stout somewhat squarish plates which run without interspaces down the exact centre of the arm. Like the primary radial they have a distinct longi-

tudinal ridge which is especially prominent in the proximal region of the arm. It is probable that this ridge is a paxilla-shaft.

On each side of the radialia is one broad row of adradialia which alternate with that series and are distinctly six-sided. A stout broad paxilla-shaft extends from each of these. There are at least two other rows of adradialia on each half of the arm, and possibly there may be a third row just at the base. These outer adradialia are all distinctly smaller than the first row, and appear to have longer and thinner paxilla-shafts. The extra length of the spine may be only apparent and due to the fact that the ossicles are slightly displaced and lie on their sides so that they are seen partially in profile view. At any rate, the appearance presented is very characteristic not only of this but of related species (compare also Text-fig. 92, p. 143).



TEXT-FIG. 88.—Plan of ossicles on the apical surface of *Urasterella thraivensis.* Lettering as in Text-fig. 92, p. 143. × 6.

A distinct row of infero-marginalia borders the arm. The sutures between these ossicles run at an angle to a line measured across the breadth of the arm. Frequently the ossicles look as if they overlap. All these rows of ossicles persist throughout 37 mm. of the length of the arm, but distally the differentiation between the ossicles becomes less obvious and the paxilla-shafts less pronounced. The structure of a considerable portion of the distal end of the arm cannot be made out.

The odontophor is not visible in apical view. The disc immediately over the odontophor is covered by one or two small paxillæ which occupy the interradial angles.

Oral Surface (Plate IX, fig. 2; Plate X, fig. 1; Text-fig. 89).—The best oral views are shown by casts from D. 254. An account of the structure of the mouth-parts is given (pp. 133–4) and of the adambulacralia and ambulacralia (pp. 134–5).

Arm in Cross-section.—The cross-section of the arm must have looked somewhat similar to that figured for *U. pulchella* (Text-fig. 80, p. 128). The apical

surface of the arm is well rounded though somewhat flattened in the median region. Possibly the flattening is due to post-mortem pressure and the arm may have been originally more tumid. The entire oral surface is occupied by the adambulacralia, which also help to form the margin. Succeeding the adambulacralia are well differentiated infero-marginalia. Between the infero-marginalia and the stout radialia are three rows of radialia. The paxilla-shafts are well seen in this view.

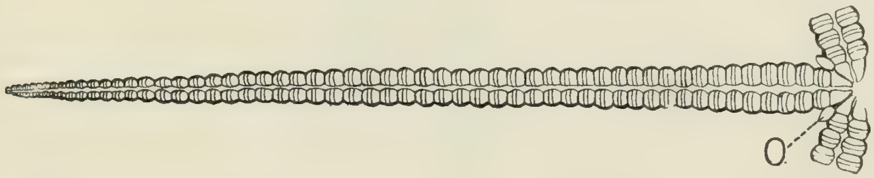
Measurements.—D. 111 has R : r : : 51 mm. (at least) : 3 mm. Width of arm at base about 4 mm.

Width of arm at base of D. 254 is 3·6 mm.

Width of arm at base of D. 35 is 4 mm.

Width of arm at base of D. 230 is 3 mm.

This last specimen seems to show the arm in full length—R : r : : 44 mm. : 3 mm. There appear to have been between fifty and sixty adambulacralia down each side of the arm. The infero-marginalia are equal in number to the adambulacralia.



TEXT-FIG. 89.—Plan of ossicles on the oral surface of *Urasterella thraivensis*. *O.*, odontophor. × $2\frac{1}{2}$.

Horizon and Locality.—Upper Ordovician (Ashgillian) of Girvan, Ayrshire, Scotland.

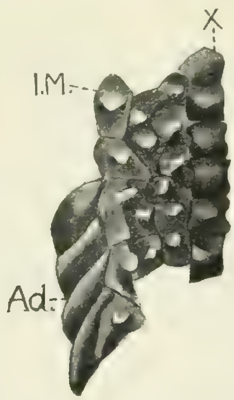
Food.—A mould of a small gasteropod is just within the mouth-angle plates of D. 254. This is a fact of some interest, as it shows the forms had the power of engulfing fairly large particles, and therefore did not depend upon ciliary action for their food.

Description of D. 46 *and* 46*c* (Text-fig. 81, p. 129).—This small specimen is undoubtedly an immature form of the species. It is much more stellate than the adult; R : r : : 4 mm. : 1·8 mm. The plates of the disc are exactly as in the holotype. It is interesting to note, however, that the adradialia on the left side of the figure are very incompletely developed. The infero-marginalia are well differentiated. In fact they appear to be more prominent as marginal plates, viewed either orally or apically, than they are in the mature form. Schuchert has also noted this latter fact with regard to the young of *U. ulrichi* (85, p. 185). The paxilla-shafts of the radialia are more spicular than in the holotype. I have not been able to distinguish the markings of the madreporite. The transverse ridges of the adambulacralia are not readily made out.

2. **Urasterella ruthveni** (Forbes). Plate IX, fig. 5; Plate X, figs. 4—6; Text-figs. 90, 91.

1848. *Uraster ruthveni,* Forbes, Mem. Geol. Surv. Gt. Brit., vol. ii, pt. 2, p. 436.
1849. „ „ Forbes, Brit. Organic Remains, Mem. Geol. Surv., dec. i, p. 1, pl. i, fig. 1.
1851. *Urasterella ruthveni,* McCoy, Brit. Palæoz. Foss., p. 59.
1854. *Uraster ruthveni,* Murchison, Siluria, fig. 39—3.
1857. *Palæaster ruthveni,* Salter, Ann. Mag. Nat. Hist., ser. 2, vol. xx, p. 326.
1862. „ „ Wright, Mon. Brit. Foss. Echinoderm., Oolitic, vol. ii, pt. 1 (Palæontogr. Soc. for 1861), p. 25.
1914. *Urasterella ruthveni,* Schuchert, Fossilium Catalogus, Animalia, pt. 3, pp. 28, 44, 45.
1915. „ „ Schuchert, Bull. 88, U.S. Nat. Mus., pp. 174, 175, 187.

Material.—Moulds of five specimens are known, all in the Sedgwick Museum, Cambridge. Specimens *a*/920, *a*/921, *a*/510 are from the Bannisdale Slates, High



TEXT-FIG. 90.—Wash drawing of a portion of the apical surface of *Urasterella ruthveni.* *Ad.*, adambulacralia; *I.M.*, infero-marginals; *X*, adradials. × 6.

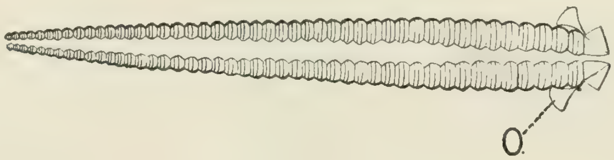
Thorns, Underbarrow. A cast from *a*/920 is figured by Forbes, and this mould is taken as the holotype of the species. Upon the same slab as *a*/921 are two moulds of *Palasterina primæva*, Forbes. B1 and B2 are from the Bannisdale Slates, N. End of Benson Knot. B1 is a large specimen. B2 shows a portion of one arm in side view.

Specific Characters.—Ridge on adambulacralia set on distal edge of oral surface. Ambulacralia long and narrow.

Apical Surface (Plate IX, fig. 5; Text-fig. 90).—Unfortunately this surface is not well shown, for no views can be obtained of the disc, and the arrangement of the ossicles on the arm can only be made out very imperfectly. The text-figure is drawn from a cast of the side view of the arm (B2). Upon the left side may be seen some of the adambulacralia. Adjoining these are long overlapping inferomarginalia of the usual Urasterellid paxillar form. Three rows of rather irregularly scattered adradialia are next seen, while indications of another row of similar ossicles are suggested.

Oral Surface (Plate X, figs. 4—6; Text-fig. 91).—Except the fragment of

the arm referred to, all the specimens show the forms in oral view. Text-fig. 91 is a plan of the disc and one reconstructed arm of the holotype. The arm used in the reconstruction is the longest arm shown in the photograph (Pl. X, fig. 4). Probably this represents the extreme length, but this is not certain. The other four arms are broken off short. The disc is as usual small (r : 2·5 mm.). The arms are long (R : 27 mm. at least) and slightly petaloid at the base. The mouth-angle plates are of about the same comparative size as in *U. grayæ*, and they are succeeded by forty-seven adambulacralia. Each adambulacral is crowned by a sharp ridge placed not medially but distinctly distalwards. The distal position of the ridge gives the adambulacralia a peculiar appearance, making them look like a succession of cups fitting into one another. The ridge is continued well on to the lateral surface. Pustular elevations for the attachment of spines may be seen on some of the proximal ridges. A number of the adambulacralia have broken away from the right side of this arm, thus allowing one to obtain a good view of the groove. The inner steep sides of the adambulacralia are well exposed, as also are the noses. The usual slope may be also observed. In fact the appearance is



TEXT-FIG. 91.—Plan of ossicles on the oral surface of *Urasterella ruthveni*. *O.*, odontophor. × 3

exactly as in *U. grayæ*. The ambulacralia, on the other hand, look at first sight quite different from those of that species, for the ambulacral ridges are very sharp and steep and appear to run straight across the ossicle. Really the same ⌋-shaped ridge is present in both species, although the short arm of the ⌋ bordering the ambulacral canal is not prominent in *U. ruthveni*. If the ossicles are slightly displaced they appear just as in Schuchert's drawing of the ambulacralia of *U. grandis* (85, pl. xxx, fig. 3) which is obviously a drawing of the ridges of successive ossicles without sufficient representation of the plates to which they are really attached.

The odontophors may be seen both in the holotype and in *a*/510. They fit very closely into the interradial angles and reach well up towards the apical surface.

Casts from B1 give good views of the plates of the mouth-region. The arrangement is almost precisely similar to that described for *U. grayæ*. The groove is widely open in this specimen and in one of the arms of B2. No point beyond those already stated seems to call for mention.

a/921 is a smaller specimen than the holotype. One of the arms is undoubtedly present in full length, and hence gives the exact relationships between the major and minor radii (see below).

Side View.—There appear to be about thirteen adambulacralia to the first nine infero-marginalia. They seem to retain this proportion (about three to two) throughout the greater part of the length of the arm. This is most clearly seen in *a*/921, where one of the arms shows a side view of all the regions except the extreme tip. Twenty-three infero-marginalia can be counted occupying the same length as thirty-four adambulacralia.

Cross-Section.—One of the arms of the holotype has not been fully exposed, and in consequence a mould of a cross-section about half-way along its length is visible. The apical surface is rounded (and perhaps ridged), but it is not tumid as in *Salteraster asperrimus.*

Measurements.—

a/920 (the holotype) R : r : : 27 mm. (approx.) : 2·5 mm.
Width of arm at base is 2·5 mm.
a 921 R : r : : 19 mm. : 2 mm.
Width of arm at base is 2 mm.
a/510 Width of arm at base is 2·6 mm.
B1 R : r : : 50 mm. (approx.) : 3·5 mm.

Horizon and Locality.—The Bannisdale Slates (Upper Ludlow) of the Lake district of Westmoreland. Professor Marr tells me that all these Westmoreland starfish beds occur at about the same horizon, namely, near the junction of the Bannisdale Slates and Kirkby Moor Flags.

History.—This species was the earliest Palæozoic starfish to be described. Forbes remarks that it "was discovered by Mr. John Ruthven, in strata of the Ludlow division of Silurian rocks at Scalthwaiterigg, etc." Forbes gives the measurement of the arms five times as long as the disc is broad. This is almost exactly the measurements given here—2r = 5 mm., R = 27 mm. He also states that the largest specimen examined measured 3½ inches (88 mm.) from arm-tip to arm-tip. This must be a specimen unknown to me, for the arms of the Sedgwick Museum specimens, as exposed by Forbes, were not nearly so large.

No one has described the species since Forbes' time. Schuchert (85, pp. 176, 177), however, saw the relationship between it and the American species of *Urasterella*, but as he had no material of the genotype for study he accepted *U. grandis* as the genotype for the time being. It is clear that Schuchert was right in his recognition of the affinities of the American species.

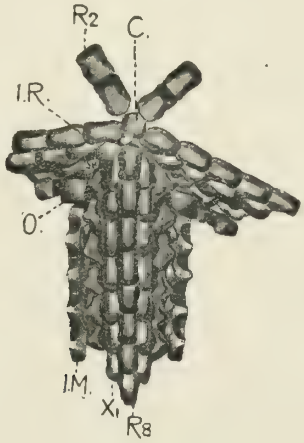
2*a*. **Urasterella ruthveni,** var. **leintwardinensis,** nova. Plate IX, figs. 3, 4; Text-fig. 92.

Material.—There are three moulds of the species, all from the well-known Church Quarry at Leintwardine. One mould is in the Ludlow Museum, a second

is in the Manchester Museum (L. 11020), and a third is in the Royal Scottish Museum, Edinburgh. All three show the apical surface only. The first two give excellent casts, the third is but a poor specimen. The specimen in the Ludlow Museum is taken as the holotype of the variety.

Varietal Characters.—The apical surface of the specimens alone is known, while only the oral surface of *U. ruthveni* can be observed in any considerable detail. Nevertheless, one can reasonably surmise that the specimens represent a variety differing mainly in size from the typical examples of the species.

Apical Surface (Plate IX, figs. 3, 4; Text-fig. 92).—The arrangement of the plates of the disc, which is exceedingly primitive, has already been referred to (pp. 128–9). The conical centrale is somewhat sunk, which makes the five



TEXT-FIG. 92.—Wash drawing of a portion of the apical surface of *Urasterella ruthveni*, var. *leintwardinensis*. *C.*, centrale; *I.M.*, infero-marginalia; *I.R.*, interradialia; *O.*, odontophor; *R.*, radialia; X_1., first row of adradialia. The madreporite may be seen in the left interradius just proximal to the odontophor. × 10.

primary radialia appear very prominent. There are two small plates besides the madreporite in the madreporic interradius of the holotype. It has already been suggested that the larger plate near to the madreporite is a primary interradial. The homology of the second smaller plate is not so clear. If it were in an adjoining interradius one would regard it as an anal plate. All the plates fit as if they were lying undisturbed in their natural position, and there is a faint suggestion of an anal plate in its proper interradius. One must regard it as an accidental division of the centrale, as it is only visible in this specimen and not in L. 11020. The proximal edge of a primary radial is convex, and the remaining edges are straight. The succeeding radialia have indented sides, so much so that those at the base of the arm are almost stellate. This shape is lost from about the sixteenth radial onwards when the ossicles become oblong. Each radial has a prominent longitudinal ridge. The first row of adradialia are, as in *U. grayæ*, almost as large as the radialia. Their bases are more distinctly stellate, and the paxilla-shaft more thorn-like, than in the case of the corresponding structures of

the radialia. The adradialia of the second row have pronounced stellate bases and thin paxilla-shafts. A third row of very small adradialia may be seen at the bases of the arms. It is obvious that when the animal was alive, and the apical surface consequently swollen, the ossicles formed a slightly open network through which papulæ could be protruded. The apical ossicles of *U. grayæ* seem to form a closer covering. The odontophor is visible on the apical surface.

The infero-marginalia form a close overlapping border, each with a distinct paxilla-shaft sticking out edgeways. Below the infero-marginalia the ridges of the adambulacralia are readily discernible. There are about sixteen adambulacralia to the first thirteen infero-marginalia. In the distal portion of the arm there are suggestions that the adambulacralia and infero-marginalia are equal in number.

The distal apical plates, as in *U. grayæ*, are not strongly paxilliform and are more closely fitting.

The specimen from the Manchester Museum shows adambulacral spines 1·2 mm. long.

Measurements.—Ludlow specimen. R : r : : 14 mm. : 1·5 mm.
Width of arm at base is 1·5 mm.
Manchester ,, R : r : : 20 mm. : 1·9 mm.
Width of arm at base is 2 mm.

Horizon and Locality.—The Leintwardine (Lower Ludlow) beds of Herefordshire.

3. **Urasterella gutterfordensis,** n. sp. Plate X, figs. 2, 3.

Material.—Five moulds are known, four in counterpart. They were found at Gutterford Burn, and are in the Collection of the Royal Scottish Museum registered as 5, 29; 85, 99; 67, 93; 14, 122; 70. The moulds give excellent casts. Specimen 93 and its counterpart are taken as the holotype of the variety.

Specific Characters.—The adambulacral ridges and the ambulacralia are as in *U. thraivensis,* but there is the small plate additional to the centrale which is characteristic of *U. ruthveni.* Mouth-angle plates small.

Apical Surface (Plate X, fig. 2).—The best casts of the apical surface are given by mould 93. The disc shows a centrale together with an extra plate as in *U. ruthveni*, var. *leintwardinensis.* Surrounding these are six prominent plates which are doubtless the five primary radialia and the single primary interradial. A madreporite has not been recognised, probably because of the small size of the specimen. Unfortunately, the exact arrangement of the other apical plates is very difficult to determine, and I do not feel justified in giving an exact drawing. They seem to me, however, to conform to the *Urasterella*-plan already described. Prominent paxilla-shafts from the apical plates are seen both in this specimen and in casts from 70. These latter casts also show thin overlapping infero-marginalia. An odontophor can be seen in each of the interradial angles.

The adambulacralia are better seen in apical view in the majority of these specimens than is usual. This is because the ambulacral groove has been forced widely open with the result that the ambulacralia are thrust well on to the sides of the arm. The dislocation is helped, of course, by the fragile nature of the form.

Oral Surface (Plate X, fig. 3).—As already mentioned, the groove in four of the specimens is widely open, and the ambulacralia are thus fully exposed. They are of the type already described for *U. grayæ*. Each is surmounted by a stout ⌋-shaped ridge, the long arm of the ⌋ being set somewhat obliquely to the main body of the ossicle. Good views of the ambulacralia are seen in the photograph (Pl. X, fig. 3). The inner faces of the adambulacralia, which in the natural position would form a steep wall to the groove, are crushed outwards so that they lie flush with the ridges of the ambulacralia. This position makes the true oral ridged faces curve proximalwards exactly as we shall see they do in *Sturtzaster* (see below). The mouth-angle plates are so small that they can only be recognised with difficulty. The first ambulacralia, on the other hand, are very stout and form a closed ring round the mouth. Each possesses a deep central depression for the first tube-foot.

An odontophor can be seen in each of the interradial angles.

Casts from mould 70 show the arms somewhat coiled and the groove closed. The ridges on the adambulacralia are especially discernible on this specimen.

Measurements.—93 gives R : r : : 10 mm. : 1 mm. The remaining specimens are of about the same size.

Horizon and Locality.—The Starfish-bed of Gutterford Burn (Wenlockian), Pentland Hills.

Note.—It is difficult to connect this species with either *U. thraivensis* or *U. ruthveni.* At first sight it might seem to be the small beginnings of the *U. ruthveni* lineage, but the Wenlockian of Gotland (see p. 147) contains a much larger and more typical specimen of that lineage, suggesting that we must look for the roots of the lineage in older strata.

American Species of Urasterella.

Urasterella pulchella, Billings.—This species has been fully described by Schuchert (85, pp. 178–180) and Hudson (93, pp. 117–139). It is found in the Trenton (M. Ordovician) formation of New York and Canada. The cross-section of the arm reproduced here (Text-fig. 80) shows that adradialia of the first row (the supero-marginalia of Schuchert and Hudson) are conspicuously larger than the remaining adradialia, and the species therefore is a true *Urasterella.* Other details of the structure have already been incorporated in the preceding general account of the structure of the family and genera. The species may attain a large size (R : r : : 52 mm. : 11 mm.). This is larger than any English species.

Urasterella medusa, Hudson.—The structure of the arm, as shown by Hudson (93, pl. 3, fig. 2), suggests that this is a true *Urasterella*. The only specimen discovered is from the Trenton beds.

Urasterella ulrichi, Schuchert.—The figures and description given (85, pp. 183–185) leave no doubt that this is a true *Urasterella*. The species may become very large (R : r : : 78 mm. : 12 mm.). Schuchert states that in the angles between all the apical plates " are left subcircular small openings." These must have been for papulæ. The radialia are not in series but are separated by adradialia which have thrust themselves between the plates very much as in *Promopalæaster* (Text-fig. 52, p. 93) and *Uranaster* (Text-fig. 61, p. 106), a suggestion that the lineage to which the species belongs is reaching its maximum of elaboration. The arms are highly convex. Schuchert notes (*op. cit.*, p. 185) that "the best preserved specimen of *U. ulrichi* has two nearly full-grown rays and three short stumps. One of these short rays is so well preserved as to indicate that this condition is not due to poor preservation, but is apparently a case of accidental loss of parts during life. The wound has been healed, but no regeneration of lost parts has taken place, as is so common in similar losses among the living starfishes." This account should be compared with that given for regeneration in *Cnemidactis* (p. 161).

The specimens are from the Black River (Middle Ordovician) formations of Minneapolis, Minnesota. It is interesting to find such an elaborated form at this early age.

The following species of *Urasterella* are mentioned but not described by Clark, J. M. (94, p. 36): *U. ruthveni*, mut. *arisaigensis*, nov.; *U. lutheri*, n. sp.; *U. stella*, n. sp.; *U. schucherti*, n. sp.; *Urasterella*, n. sp.

German Species of Urasterella.

Urasterella asperula, Roemer.—Schuchert has shown (85, pp. 188–189) that the specimens of this form in the United States National Museum and the Yale Museum belong to species of a true *Urasterella*. I have examined the specimens in the British Museum (Nat. Hist.) figured by Stürtz as *Rœmeraster asperula* (76, pl. ix, figs. 4, 5). The apical surface shows a very similar structure to *U. ruthveni*, var. *leintwardinensis*. The form is larger, however, than any found in England, and there is a loss of symmetry of the central plates on the apical surface of the disc. I am inclined to regard it as merely a horizon variety of *U. ruthveni*.

Specimens are fairly common in the roofing slate of the Lower Devonian of Bundenbach, Germany.

French Species of Urasterella.

Schuchert suggests (85, p. 187) that the *Asterias constellata* of Thorent

(96, p. 259, pl. 22, fig. 7) may belong to *Urasterella*. He remarks: "The original figure of this species does not permit of determining its generic position. It is described as having but one range of plates on each side of the ambulacral grooves, and the figure seems to indicate the presence of a large disc with well-defined interbrachial arcs. It seems to have more of the characters of *Urasterella* than of any other genus. The specimen was found in the Siluric (? Lower) strata in Northern France (Mondrepuis, L'Aisne)."

Scandinavian Species of Urasterella.

The Mineralogical Museum at Copenhagen contains a specimen which is almost certainly of *U. ruthveni*, var. *leintwardinensis*. It shows the oral surface and presents the same characters as *U. ruthveni*, and is from the Silurian (Wenlock) of Wisby, Gotland. It is registered as No. 231. I am indebted to Dr. Bather for permission to investigate this specimen, which was lent to him. Measurements give R : r : : 22 mm. (approx.) : 2·5 mm.

Russian Species of Urasterella.

The Russian Carboniferous species described by Schöndorf (65, pp. 323–327, pl. xxiii, fig. 1; pl. xxiv, figs. 20–22) under the name of *Palæaster montanus* (Stschurowsky) is undoubtedly nearly related to *Urasterella*. This was recognised by Schuchert (85, p. 189) who named the species *Urasterella montana*. There is a well-preserved specimen of the form in the British Museum (Nat. Hist.) registered as E. 3806. I have investigated it, and make the species have the following diagnostic characters: General arrangement of the plates in cross-section of the arm as in *U. ruthveni*. Paxilla-shafts shaped like an inverted cone with a flat broad top. Infero-marginalia with ridge-like paxilla-shafts. Ambulacralia much reduced.

The following notes on the structure add somewhat to our previous knowledge.

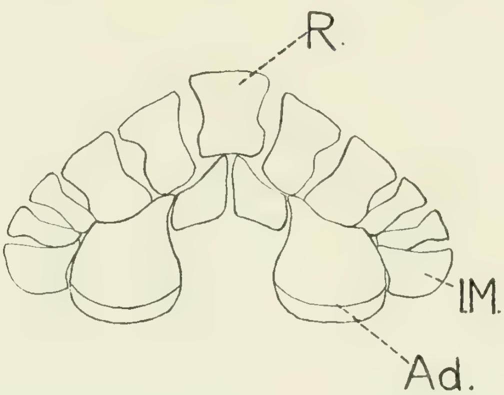
That the species is a *Urasterella* is shown by the cross-section (Text-fig. 93). The adambulacralia have the usual "Urasterellid" form, and the apical plates are paxilliform and have the *Urasterella* arrangement. This cross-section differs considerably from that figured by Schöndorf (*op. cit.*, pl. xxiv, fig. 22). I cannot reconcile the high swollen form and thin ossicles of that figure with the appearance presented by the British Museum specimen, or with that which one would expect for a species of the Urasterellidæ.

The adambulacralia are as figured by Schöndorf (*op. cit.*, fig. 22 A). He does not appear, however, to have noticed the "Urasterellid" ridge which is low but distinctly visible. At least one long spine which must have articulated with the ridge is present.

The ambulacralia are as described by Schöndorf, small and strongly compressed in a proximal-distal direction. They differ considerably from those of the previously described species of *Urasterella,* and resemble in cross-section more the ambulacralia of *Calliasterella mira* (Text-fig. 111, p. 167).

The proximal infero-marginalia have a distinct ridge instead of the usual spine-like paxilla-shaft. The paxilla-shaft of the remaining apical plates is stout and shaped like an inverted cone. Small granular spines seem to have fitted on to the flat top of this cone. These may be, of course, merely the basal remains of original long spines.

The centre of the apical region was not described by Schöndorf. I have been able to expose it, but the exact arrangement of the plates is hidden by the mass of granular spines.



Text-fig. 93.—Cross-section through an arm of *Urasterella montana.* *Ad.*, adambulacral; *I.M.*, infero-marginal; *R.*, radial. × 15.

The mouth-parts, as seen in external view, including the odontophor, are exactly as in the described species of *Urasterella.* Schöndorf (*op. cit.*, fig. 21 b) figures them as seen from the ambulacral groove, and shows no ambulacral corresponding to the mouth-angle plates. In the British Museum specimen the mouth-region is sunk, and one cannot expose the plates sufficiently to decide whether this view be correct. The excellent photograph given by Schöndorf (*op. cit.*, fig. 1) suggests that the specimen which he investigated would also not yield good exact views of the groove in the mouth-region. At any rate, his figure is not compatible with any arrangement known in the Urasterellidæ.

The measurements of the specimen described by Schöndorf are given as R = (about) 35 mm.; r = 6–7 mm. The breadth of the arm at about its middle is about 6 mm. The dimensions of the specimen in the British Museum are R = (about) 22 mm.; r = 4 mm. The breadth of the arm near the middle is about 6 mm.

Both specimens are from Mjatschkowa, near Moscow. According to Kayser the beds belong to the lowest series of the Upper Carboniferous (Schöndorf, *op. cit.*, p. 326).

Genus **SALTERASTER**, Stürtz.

1893. *Salteraster*, Stürtz, Verhandl. Naturh. Ver. preuss. Rheinl., Jahrg. 50, pp. 43, 60.
1914. „ Schuchert, Fossilium Catalogus, Animalia, pt. 3. pp. 7, 37, 44.
1915. „ Schuchert, Bull. 88, U.S. Nat. Mus., pp. 173, 178.

Generic Characters.—A Urasterellid with all its rows of adradialia exactly similar.

Stürtz, in one of his reviews of the Palæozoic genera, suggested various names for species which did not seem to him to belong to the genera to which they were ascribed. Amongst other changes he suggested the new generic name *Salteraster* for the species named by Salter *Palæaster asperrimus.* No diagnosis of the genus was given, for no very adequate description of the form had been published. Nicholson and Etheridge (54, p. 320), indeed, wrote as follows: "*Palæaster asperrimus*, Salter, is an unsatisfactory species. The specimens in the Museum of Practical Geology have the large transverse ossicles [adambulacralia] very apparent; but as to whether there is a row inside or outside these, or both, we are by no means certain. It appears, however, to have possessed only four rows [that is only ambulacralia and adambulacralia alone were visible on the oral surface; marginalia were not visible]." They quite rightly point out (*op. cit.*, p. 326) that this structure of the arm brings the form into close relationship with their "*Tetraster*, sp. ind.," which is the geno-holotype of my genus *Cnemidactis* (p. 156).

Schuchert (85, p. 187) in view of these remarks says: "It seems best under these circumstances to refer this species to *Urasterella*, it being apparently near *U. grandis*. . . . Should it prove to be generically different from *Urasterella*, then the name *Salteraster*, Stürtz, can be revived, as he names *P. asperrimus* as the geno-holotype." I think that if Schuchert had had the specimens of *P. asperrimus* for examination, he would not have regarded the species as being generically distinct from *Urasterella*, for it is certainly nearly akin to at least two species, *U. grandis* and *U. huxleyi*, which he places in that genus. Personally, however, I think that the characters given above warrant a generic distinction.

1. **Salteraster asperrimus** (Salter). Plate XI, figs. 3, 4; Text-figs. 94—97.

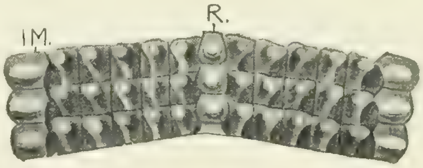
1857. *Palæaster asperrima*, Salter, Ann. Mag. Nat. Hist., ser. 2, vol. xx, p. 325, pl. ix, fig. 1.
1862. „ „ Wright, Mon. British Foss. Echinoderm., Oolitic, vol. ii, pt. 1 (Palæontogr. Soc. for 1861), p. 24, fig. 15 (1).
1866. *Palæaster asperrimus*, Salter, Mem. Geol. Surv. Gt. Britain, vol. iii, pp. 289, 394, pl. xxiii, figs. 2*a*, 2*b*, 2*c*.
1880. *Tetraster* (?) *asperrimus*, Nicholson and Etheridge, Mon. Silurian Foss. Girvan Dist., Ayrshire, fasc. 3, pp. 320, 321, 326.

1886. *Palæaster* (?) *asperrimus*, Stürtz, Palæontographica, vol. xxxii, p. 91.
1893. *Salteraster asperrimus*, Stürtz, Verhandl. Naturh. Ver. preuss. Rheinl., vol. Jahrg. 50, pp. 43, 60.
1914. *Urasterella* (?) *asperrima*, Schuchert, Fossilium Catalogus, Animalia, pt. 3, pp. 37, 44.
1915. *Urasterella* (?) *asperrima*, Schuchert, Bull. 88, U.S. Nat. Mus., p. 187.

Material.—Moulds of portions of three individuals are known, in the Museum of Practical Geology, Jermyn Street. The holotype figured by Salter consists of both mould and counterpart (7435 and 7436). The other two specimens (25335 and 25336) are moulds of portions of the apical surface. The holotype is preserved in rather a curious position, the arms not radiating but bunched together (Pl. XI, fig. 3). The specimen of *U. grandis* figured by Schuchert (85, pl. xxviii, fig. 1) is also preserved in this position.

Specific Characters.—Arms highly convex, cylindrical, long. Radialia stout.

Apical Surface (Plate XI, figs. 3, 4; Text-fig. 94).—Unfortunately none of the specimens are in a sufficiently good condition to allow one to make a plan of the whole of the apical ossicles with any certainty. The moulds of all the specimens



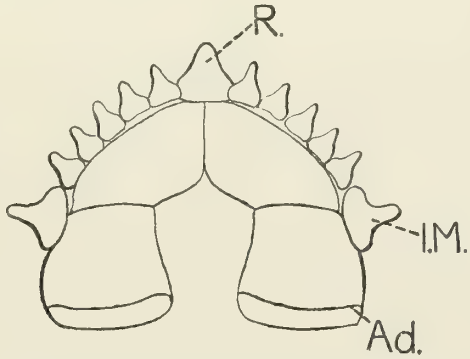
TEXT FIG. 94.—Wash drawing of a portion of the apical surface of the arm of *Salteraster asperrimus*, slightly diagrammatised. *I.M.*, infero-marginalia; *R.*, radialia. × 5.

are broken, so that only a portion of the disc is preserved. One of the arms of the holotype is preserved in full apical view, but the mould of this is cracked down the middle. In consequence, only portions of the arm can be studied, but these allow one to obtain a fairly complete idea of the arrangement of the arm-ossicles.

Text-fig. 94 shows the arrangement of the ossicles at about the middle of the arm-length. The arm is bordered by stout, almost circular, infero-marginalia, each with an inner nose and a stout paxilla-shaft. The middle of the arm is occupied by prominent radialia. These have a stellate base, much more circular in appearance than in *U. ruthveni*, var. *leintwardinensis* and *U. thraivensis*. In fact they look very similar to the radialia of the American species *U. grandis* (85, p. 27, fig. 6). They follow one another in regular sequence. Between the radialia and infero-marginalia there are five rows of adradialia, all of which are very similar in appearance. Each adradial looks as if it were **V**-shaped with the point of the **V** directed towards the margin. If a displaced ossicle be examined it is seen that this is not the real shape. The base is quadrate rather than triangular, but carries on it a somewhat wedge-shaped paxilla-shaft. The broadest end of the shaft is the inner extremity, from which it tapers somewhat outwards. The result is that the paxilla-shaft makes the whole ossicle look **V**-shaped in surface view. Reference

to somewhat similar ossicles in species of *Promopalæaster* are made in the previous section of this monograph (pp. 91, 92). The reference made on p. 92 to *U. primæva* is wrong. This species (*S. asperrimus*) should have been named.

The photograph of the cast does not give a good idea of the length of the paxilla-shafts. The moulds show deep pits, but it is not easy to get good casts from these. The height of the shaft is best shown in Text-fig. 95.

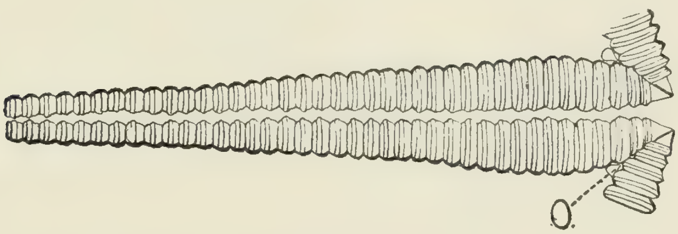


TEXT-FIG. 95.—Cross-section through the arm of *Salteraster asperrimus*. ***Ad.***, adambulacralia; ***I.M.***, infero-marginalia; ***R.***, radialia. × 10.

The arrangement of the plates of the disc is not certain. All the specimens suggest that the adradialia and radialia follow the Urasterellid disposition as shown in Text-fig. 81. The holotype shows a madreporite, and I think that I can recognise a centrale and a primary circlet of plates in 25335 and 25336.

A slight displacement of the plates in 25335 allows one to get a good apical

96



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TEXT-FIG. 96.—Plan of the oral surface of *Salteraster asperrimus*. *O.*, odontophor. × 2½.
TEXT-FIG. 97.—Wash drawing of the adambulacralia at the extremity of the arm of *Salteraster asperrimus*. × 6.

view of the ambulacralia. These are thick and high, exactly as described for *U. pulchella* by Hudson (93, pp. 124 and 136). The thick ambulacralia in themselves cause the arm to appear convex (Text-fig. 95).

Oral Surface (Plate XI, fig. 4; Text-figs. 96, 97).—In the Text-figures the groove is shown as closed. The whole breadth of the arm is occupied by the stout adambulacralia which completely hide the ambulacralia.

The mouth-parts are almost exactly as in *Urasterella*. The more proximal

adambulacralia increase in size distally until they reach a point a little distant from the base of the arm, where the arm has its greatest breadth. In consequence, the arms appear slightly petaloid.

Each adambulacral has a very distinct crest, which starts from the extreme margin of the arm and runs across the distal portion of the ossicle so as to end in a sharp point in the middle of the groove. Pustules for the articulation of the spines were present on the crest. It is not easy to determine the exact number, but I believe that there were about eight. The broken bases of the spines may sometimes be seen in the depression between the crests.

Displaced ossicles show proximal and distal hollows for the interadambulacral muscles, and the great thickness of the adambulacralia. A view of the interior of the groove is presented by two other arms. The characteristic knee-shaped bend (see p. 134) is well seen.

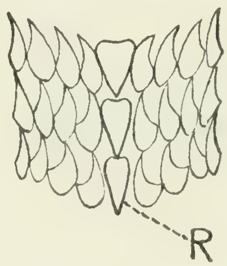
Measurements.—R : r : : 36 mm. : 6 mm. Breadth of arm at base is 6·4 mm.

Horizon and Locality.—The Upper Ordovician (Caradoc beds) of the Quakers' burying ground, near Welshpool.

2. **Salteraster ? imbricatus** (Salter). Plate XI, fig. 5; Text-fig. 98.

1866. *Palæaster imbricatus*, Salter, Mem. Geol. Surv. Gt. Brit., vol. iii, pp. 289, 407, 480, pl. xxiii fig. 8.
1914. *Tetraster ? imbricatus*, Schuchert, Fossilium Catalogus, Animalia, pt. 3, pp. 28, 42.
1915. *Tetraster ? imbricatus*, Schuchert, Bull. 88, U.S. Nat. Mus., pp. 168, 169.

Material.—The only materials are two poor casts of the holotype of the species



Text-fig. 98.—Diagram-plan of some of the ossicles on the apical surface of *Salteraster imbricatus*. *R.*, radialia. × 4.

in the Museum of Practical Geology, Jermyn Street (No. 28364). The natural mould from which the casts were taken is stated by Salter to be "in the collection of Mr. Prosser," but I have been unable to trace it.

Specific Characters.—Body stellate, arms convex. Radialia small.

Description.—Only portions of two arms and of the disc are preserved. The form seems to have been distinctly stellate, the arms being much more pointed than

in *S. asperrimus.* The arms are swollen. Salter describes them as somewhat carinate. According to my observations the keel is very slight, if present at all. I should describe the arms as being cylindrical. The radialia are small, irregularly-shaped plates not nearly so large or swollen as in *S. asperrimus.* The adradialia are similar and arranged in rows which form a sharp V across the middle line of the arm. It is this arrangement of the radialia which makes the apical surface of the arm at first sight appear carinate. There is a distinct suggestion that each adradial had a stout paxilla-shaft.

The disc is almost bare of plates, only a few remaining near the edge. These appear to be very similar in character to the adradialia. R : r : : 14 mm. : 3·5 mm. These measurements are made from the left-hand arm which appears to be preserved in almost full length.

Horizon and Locality.—Upper Ordovician (Caradocian) of Llanfyllin, Montgomeryshire.

3. **Salteraster ? coronella** (Salter). Plate XI, fig. 6; Text-fig. 99.

1857. *Palæaster coronella,* Salter, Ann. Mag. Nat. Hist., ser. 2, vol. xx, p. 326.
1862. „ „ Wright, Mon. Brit. Foss. Echinoderm., Oolitic, vol. ii, pt. 1 (Palæontogr. Soc. for 1861), p. 25.
1886. *Stenaster ? coronella,* Stürtz, Neues Jahrb. für Min., vol. ii, p. 153.
1914. „ „ Schuchert, Fossilium Catalogus, Animalia, pt. 3, pp. 28, 39.
1915. „ „ Schuchert, Bull. 88, U.S. Nat. Mus., pp. 165, 167.

Material.—A single specimen in the Museum of Practical Geology, Jermyn Street (7402) is the only material of the species. It is a mould showing the greater portion of the apical surface.

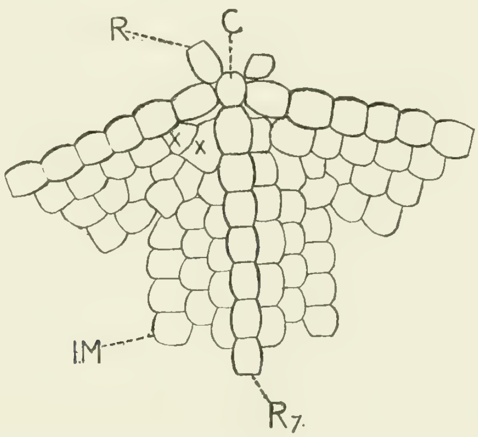
Specific Characters.—Infero-marginalia oblong, closely touching, each with a distinct transverse ridge. Radialia with a large evenly swollen boss with no distinct paxilla-shaft.

Apical Surface (Plate XI, fig. 6; Text-fig. 99).—An examination of the photograph shows that the disc has been broken away in the region of the primary circlet. The plan of the ossicles (Text-fig. 99) makes it clear that the circlet is incomplete. The four larger ossicles are undoubtedly primary radialia, and the smaller ossicle probably represents the primary interradial usually associated with the madreporite. The fifth primary radial and the madreporite are missing. If this interpretation be correct, the arrangement of the circlet is exactly as in *Urasterella thraivensis* (Text-fig. 88, p. 138). The radialia are stout and closely touching. Each has a boss-like eminence with no distinct paxilla-shaft. The matrix in which the fossil is embedded is very coarse, and there may have been originally a slender paxilla-shaft which has not been preserved.

There are two rows of adradialia very similar in appearance. All have paxilla-

shafts as in *Urasterella* and *Salteraster.* The arrangement is similar to that in *Urasterella* except that one of the pair of adradialia immediately succeeding the primary radialia is larger than the other, suggesting that the single interradial plate in this position in *Protarthraster longimanus* is the survivor of a pair of plates one of which has been suppressed (see p. 163).

The infero-marginalia are seen on the left and right arms of the photograph. They are oblong, closely touching, and have a distinct transverse ridge. They differ therefore in appearance from the same series of ossicles in *S. asperrimus.* Just beneath the infero-marginalia of the right arm of the photograph may be seen ridged plates which must be the adambulacralia. They are visible because this arm is seen slightly in lateral view.



TEXT-FIG. 99.—Plan of the ossicles on a portion of the disc and arms of *Salteraster* (?) *coronella.* *C.*, centrale; *I.M.*, infero-marginalia; *R.*, radialia; *X.*, adradialia (paired interradialia). × 10.

The plan of the ossicles shows a small interradial plate just proximal to the infero-marginalia, which may be the apical surface of the odontophor. All the apical plates are closely touching, without interspaces for the protrusion of papulæ.

Measurements.—R : r : : 7 mm. : 2·5 mm.

Horizon and Locality.—Lower Silurian (May Hill Sandstone), of Gunwick Mill, near Africk, Malvern, Worcestershire.

American Species of Salteraster.

The following two species described by Schuchert as belonging to the genus *Urasterella*, apparently really belong to *Salteraster.*

U. grandis, Meek, described by Schuchert (85, pp. 180—182).—The form is very large (R : r : : 93 mm. : 9 mm). Arms subcylindrical in outline. The rows of adradialia are not differentiated (85, pl. xxvii, fig. 6). On the disc the ossicles

are stated to be "arranged in a few concentric rows," obviously an advance on the usual primitive "Urasterellid" arrangement. Schuchert regards this species as descended from *U. pulchella*. I am not able to see any good grounds for this opinion. The specimens are found in the Richmond (Upper Ordovician) formation.

U. huxleyi, Billings, described by Schuchert (85, pp. 182—183).—Schuchert states that: "The abactinal side of the disc has a central disc plate that is large and tumid. Around it is a circle of six smaller, highly convex plates, and at the base of each ray medially there is another single large tumid plate, the basal radial [obviously the primitive 'Urasterellid' arrangement]. The abactinal side of the rays is highly convex and somewhat angulated medially. [This latter character distinguishes it from *S. asperrimus*.] The ossicles are small and distinctly arranged in quincunx, of which there are about six plates in each diagonal row near the base of a ray . . . all the ray ossicles are of equal size. R : r : : 58 mm. : 5·5 mm."

The only specimen was found in the Chazy (Middle Ordovician) beds at Point Rich, Newfoundland, and is now in the Ottawa Museum.

Australian Species of Salteraster.

Salteraster ? selwyni was described as *Urasterella selwyni* by McCoy (Geol. Surv. Victoria, Prodr. Palæont. Victoria, dec. i, 1874, p. 42, pl. x, figs. 2, 2*a*, 3, 3*a*). The figures and description suggest that the species might really belong to *Salteraster*, but good structural details are not given. The form is said to be "common in the fine sandy Silurian beds of range on E. side of commonage reserve, Kilmore."

Family Cnemidactinidæ, nova.

1914. *Urasterellidæ*, Schuchert (pars), Fossilium Catalogus, Animalia, pt. 3, p. 7.
1915. „ Schuchert, Bull. 88, U.S. Nat. Mus., p. 172.

Group C forms with arms margined by closely-knit adambulacralia and infero-marginalia. Both these series of plates covered by a uniform ornament of small spines. Apical plates of disc irregularly arranged.

The family is founded for one genus and species, *Cnemidactis girvanensis* (Schuchert), forms of which are found in considerable numbers in the Upper Ordovician (Ashgillian) of Thraive Glen, Girvan, Ayrshire. This abundance, with the large comparative size of the specimens, suggests that one has to deal with a type which has reached the maximum stage of its lineage, or, in other words, that we have to deal here, exactly as was the case in regard to *Promopalæaster*, with a genus which has already passed through various stages not at present known because of the imperfection of the geological record. We should expect to find

the form to show features more like the primitive Asterozoa than do any contemporary relations which have evolved from the parent stock at a later date than it did. It is these ancestral characters which give much interest to the study of the form. These points can clearly be seen from the following table.

(1) *Features which show the Relationships with the Urasterellidæ.*

(*a*) The small disc and long arms.

(*b*) The structure of the cross-section of the arm (Text-fig. 100). The adambulacralia occupy the whole of the oral surface and a portion of the margin. There is a row of clearly differentiated inferomarginalia above these.

(*c*) The apical covering which consists of ossicles each with a long process very like the paxilla-shaft of the Urasterellidæ.

(*d*) The structure of the mouth-parts which are typically Urasterellid. That the form is related to the Urasterellidæ was seen by Nicholson and Etheridge when they first described it (see below) and by Schuchert.

(2) *Features which are more Primitive than those of the Urasterellidæ.*

(1) The adambulacralia are covered by a large number of small spines. In *Urasterella* specialisation has resulted in the restriction of the spines to a ridge, and the spines themselves are very long and stout.

(2) The nose of the adambulacralia is not so much modified as in the Urasterellidæ.

(3) The infero-marginalia are more similar to those usually found in the Asteroidea, and have a covering of small spines. In the Urasterellidæ these marginalia have become modified into paxillæ.

(4) There is a large torus.

Genus **CNEMIDACTIS**, novum.[1]

1. **Cnemidactis girvanensis** (Schuchert). Plate VIII, figs. 5, 6; Plate XI, figs. 1, 2; Plate XII, figs. 1—5; Plate XIII, figs. 1, 2; Text-figs. 100—103.

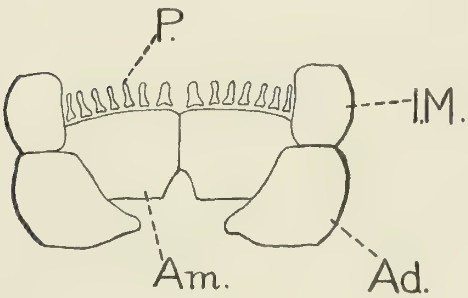
1880. *Tetraster*, sp. ind., Nicholson and Etheridge, Mon. Silurian Foss. Girvan Dist., Ayrshire, fasc. 3, pp. 325, 326, pl. xxi, figs. 9, 10.
1914. *Urasterella girvanensis*, Schuchert, Fossilium Catalogus, Animalia, pt. 3, pp. 42, 44.
1915. ,, ,, Schuchert, Bull. 88, U.S. Nat. Mus., pp. 167, 175, 186, pl. xxviii, fig. 5.

Material.—Only a mould of the oral surface of a single individual in Mrs. Gray's collection (D. 9) was known to Nicholson and Etheridge, who remark: "In some

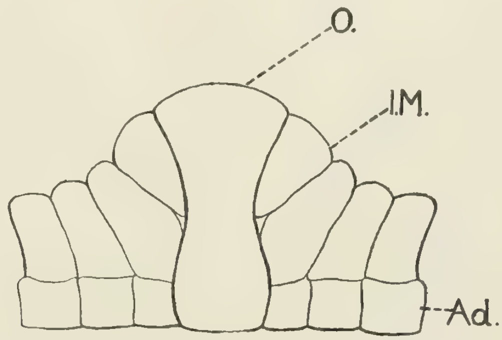
[1] (κνημις = a spoke of a wheel.)

of its characters it approaches very closely to *T. ? asperrimus*, Salter, sp.; but as we have no definite proof of the existence of the remarkable asperities of the upper surface visible in the latter, we prefer to retain the two forms separate—the more so as we have not seen any trace of the prominent spines attached to the marginal plates of the ambulacra of *T. ? asperrimus*." A wax squeeze from this same form was sent by Dr. Bather to Schuchert, who remarks (1915, p. 186): "This species is clearly a *Urasterella*, a fact which was also noted by Nicholson and Etheridge. . . . In its interbrachial skeleton *U. girvanensis* retains youthful generic characters, seen in the well-developed interbrachial axillary ossicles [the odontophors]." Schuchert was not quite sure whether the species, *Eoactis simplex*, described by me (above, p. 30) was identical with the species now under description, but *Eoactis simplex* is quite a different form.

100



101



TEXT-FIG. 100.—Cross-section through the arm of *Cnemidactis girvanensis*. *Ad.*, adambulacralia; *Am.*, ambulacralia; *I.M.*, infero-marginalia; *P.*, paxillæ. × 10.
TEXT-FIG. 101.—Plan of ossicles seen in side view in the interradial angle of *Cnemidactis girvanensis*. *Ad.*, adambulacralia; *I.M.*, infero-marginalia; *O.*, odontophor. × 10.

There are about thirty specimens in Mrs. Gray's collection from Thraive Glen. No other species except *Stenaster obtusus*, Forbes, is so abundant. It is curious to note that *Stenaster obtusus* is very widely distributed in the Ordovician of the British Isles, and a nearly related, if not identical form, *S salteri*, Billings, is abundant in the Ordovician of N. America. No form of *Cnemidactis* has been found in any other horizon or locality, except one specimen from the Llandeilo of Dow Hills in this same district in Scotland. The presence in the Girvan "Star-fish bed" of peculiar genera known at present from no other region, has been noted in respect to Trilobites and Cystids. The point will be referred to again later. The abundance of *C. girvanensis* and its excellent state of preservation allow a full description of the form to be given.

Structure of Arm (Plate XII, figs. 1, 4; Plate XIII, fig. 2; Text-figs. 100, 101).—The fundamental structure is best exhibited by the cross-section (Text-fig. 100). The sides of the arm are bordered by two series of ossicles—the adambulacralia and the infero-marginalia. The adambulacralia are the stouter of

the two series. They curve over so as to hide partially the ambulacral groove. The groove itself is arched over by stout ambulacralia. Small plates with a high paxilla-shaft form the apical covering between the edges of the infero-marginalia. The apical covering lies almost directly upon the ambulacralia, and there could have been little if any space for the body-cavity. The ambulacralia, adambulacralia, and infero-marginalia are all firmly bound together, and only very rarely can any displacement be observed. So firmly are they fixed that there is no sign that the adambulacralia had any power to roll over and close the groove. In oral view the adambulacralia form the entire margin of the arm. Each adambulacral is distinctly swollen on both oral and outer surfaces. The swelling is highest in the middle but extends almost to the margin, so that there is no differentiated narrow ridge as in the Urasterellidæ. It is ornamented by numerous small irregularly arranged pustules which probably carried spines. None of the spines remain attached, but there are many loose spines in the groove which have doubtless fallen there from the adambulacralia. There is along each adambulacral a narrow border devoid of ornament, doubtless the beginning of the differentiation which resulted eventually in the confinement of spines to a central ridge.

Further features which show the primitive condition of the ossicles of the groove are (*a*) the prominent noses of the adambulacralia, (*b*) the "flooring-plate" character of the ambulacralia. These latter are stout rectangular plates with a high ⅃-shaped ridge. Some of their outer extremities may have been slightly cut away to allow of the passage of ampullæ, but it is extremely difficult to be quite certain upon this point. The ambulacralia and adambulacralia are exactly opposite to each other. The evidence for this is especially clear in D. 82.

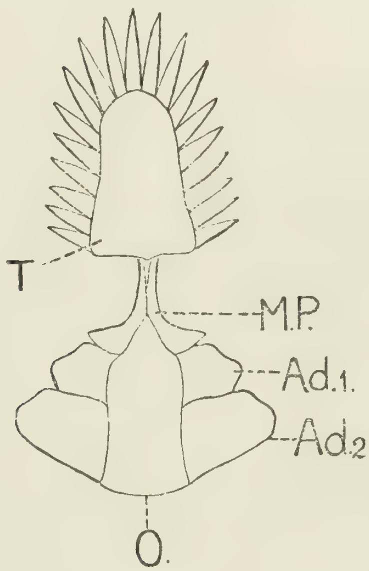
Displaced adambulacralia show that the articular faces have narrow circular concavities for the insertion of the interadambulacral muscles.

In side view the arm is seen to be steep-sided. Throughout its greater part the infero-marginalia and adambulacralia alternate. Towards the base occurs a modification which is illustrated in Text-fig. 101. The high odontophor in growing upwards has carried the proximal infero-marginal with it. The neighbouring infero-marginalia and adambulacralia are exactly opposite to each other. All the infero-marginalia are swollen in an exactly similar manner to the adambulacralia and possess the same type of ornament (D. 73).

In apical view (Pl. XII, fig. 1) the infero-marginalia only form a narrow border. Between them stretches a broad expanse of spicula-like plates which are so similar in appearance to those of *Urasterella* that one must regard them as paxillæ. In the middle of the arm these paxillæ are slightly larger than those nearer the edge, but they are so irregularly arranged that one cannot separate them into radialia and adradialia. The outer smaller spicules seem to fall more regularly into diagonal rows of six. About three of these rows occupy the same length as does an inferomarginal. Frequently the spicules have fallen away leaving the ambulacralia

completely exposed. The flat-topped appearance of the exposed ossicles is very characteristic of the species. Each fits tightly with its opposite and succeeding neighbour, the only gap being at the outer extremities where small triangular openings may very occasionally be observed. It may be that ampullæ penetrated the dorsal cavity through these openings. The tight firmly-fitting ambulacralia almost give one the impression of bricks set in mortar. The very occasional glimpses one obtains of adjoining faces show steep sides without muscle-depressions. *Cnemidactis* is obviously not a wriggling form.

Apical Surface of Disc (Plate XI, fig. 1; Plate XII, figs. 1, 2).—The disc is covered by a number of small spicular plates which do not appear to have any regular arrangement. I have been unable to discover any trace of a madreporite.



TEXT-FIG. 102.—Plan of ossicles, seen in oral view, of an interradial angle of *Cnemidactis girvanensis*. *Ad_1*., first adambulacral; *Ad_2*., second adambulacral; *M.P.*, mouth-angle plate; *O.*, odontophor; *T.*, torus. × 10.

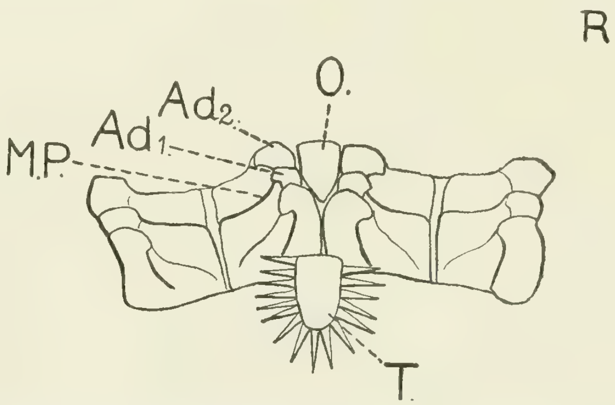
Mouth-parts.—Several of the specimens give perfect views of the mouth-parts in their natural position. Others show the same parts slightly dislocated, so that views can be obtained of individual ossicles. It is thus possible to describe this region in considerable detail.

Oral Aspect of Mouth-parts (Plate XI, fig. 2; Text-fig. 102).—The odontophor is a very conspicuous ossicle with a characteristic shape. The proximal end is wedge-shaped, the wedge fitting in between the angle made by the distal extremity of the mouth-angle plates. Distal to the wedge is a slight convexity upon which is fitted the first adambulacral. Beyond this again is a wide concavity in which sits the second adambulacral. A distinct peculiarity of the adambulacralia is the position of the nose, which is not proximal to a median transverse line as is usual amongst the Asterozoa (compare Text-fig. 18, p. 20) but distal. It will also be

noticed that both the mouth-angle plates and the first adambulacralia are very small.

A breast-plate-shaped torus, very large in surface view, projects well into the mouth-cavity. It is surrounded by spines. An examination of the photograph given Pl. XI, fig. 2, shows that the five tori and their spines completely close the mouth-cavity.

Adoral Aspect of the Mouth-parts (Plate VIII, fig. 6; Text-fig. 103).—I have made a careful model of a portion of the mouth-region. This has been photographed in such a position that one is looking at it from inside the mouth-cavity. A key-drawing to the photograph is given as the Text-figure. The first feature one notices is that the proximal ambulacralia are very large as compared with the mouth-angle plates, that is, the mouth-parts are of the "ambulacral type" of



TEXT-FIG. 103.—Outline drawing as key to the photograph of the model, Pl. VIII, fig. 6, showing an adoral view of the plates in the mouth-region of *Cnemidactis girvanensis*. Ad_1., first adambulacral; $Ad._2$ second adambulacral; *M.P.*, mouth-angle plates; *O.*, odontophor; *T*, torus. × 6.

Ludwig. The second point is the sharp dip of the ambulacralia into the mouth-cavity. In consequence, the proximal tube-feet must have been well inside the mouth as in the Ophiuroidea. The large torus is another point of similarity with the Ophiuroidea In this latter class, however, the torus is always firmly attached to the mouth-angle plates throughout its depth. In *Cnemidactis* the attachment seems to have been slight and only at the distal end of the torus. At any rate the tori are always found in this position, and are so regularly arranged that it is difficult to suppose that they were secondarily pushed there after death.

The first ambulacral is a large plate as in *Urasterella*. The ridge separating the first and second tube-feet runs in an oblique direction across the plate.

Apical View (Plate VIII, fig. 5).—The apical view is especially interesting because of its close resemblance to that of *U. medusa* (Pl. VIII, fig. 4). The only distinction appears to be, that there has been a great fusion of the ambulacralia in *Cnemidactis*. The first three pairs are usually found so that they form a thick solid bar which stretches from one odontophor to another. A similar fusion in

other species of Palæozoic Asterozoa has already been referred to (p. 33). The amount of fusion is not constant in all the specimens. Thus there is a distinct median suture in both D. 103 and D. 255.

Description of D. 255 (Plate XIII, fig. 1).—D. 255 is a small young specimen of the species which deserves special mention, showing only the apical aspect. The chief points are: (1) The ambulacralia of the mouth-region are not fused across the middle line; (2) the odontophor in side view is highly swollen and grooved throughout its entire length; (3) the proximal infero-marginalia are very little differentiated and alternate with the adambulacralia.

Measurements.—218*c* gives R : r : : 36 mm. : 4 mm. Width of arm at base is 4·2 mm. The variation in size can be judged from the following measurements of the width of the arm at the base: D. 93, 6 mm; D. 24*c*, 5 mm.; D. 255, 3·2 mm.

Horizon and Locality.—Middle Ordovician (Llandeilo) of the Dow Hills, and Upper Ordovician (Ashgillian) of Thraive Glen, Girvan, Ayrshire, Scotland.

Regeneration of Lost Parts (Plate XII, fig. 5).—A cast taken from D. 110*c* shows that the arm broke away about 8 mm. from the base and that regeneration subsequently took place. The new portion of the arm is, as one would expect in the earlier stages of growth, not so stout as the original lost part. The point is interesting because marked regeneration has not been previously noted in Palæozoic Asteroidea. Schuchert states in respect to this (85, p. 37): "Among living starfishes it is common to regrow arms that have been lost through accidental causes. From the base of the severed ray a new growing tip is established, forming a juvenile arm that gradually grows to full size and assumes mature characteristics. Schöndorf (62 pp. 96, 97) states that this habit has been pronounced since the Jurassic, but that he has failed to find marked regeneration in Palæozoic asterids. He did, however, note partial replacement of minor losses among the Devonic species. Stürtz, who has handled more Palæozoic asterids than any other palæontologist, also has not noted a single case of marked regeneration. The same is true for the 400 *Devonaster eucharis* found in a limited area of the Middle Devonic of New York. Clarke, in describing this find (1912, pp. 44, 45), however, does note a few specimens which show the existence of only four instead of the normal five arms. These are the only examples of four-rayed Palæozoic starfishes so far recorded.

"The writer has also been unable to find a single case of regeneration, but in the Middle Ordovicic cryptozonian *Urasterella ulrichi* he describes a specimen with two normally developed rays and three short stumps. All of the arms are normal for the species, except for the length of three rays and their terminations, which are blunt (see pl. xxix, fig. 1). It seems to him that this occurrence is not due to the accident of fossilisation or weathering, but is an actual case of loss in life with subsequent healing of the wounds, but without regeneration of the lost parts.

"During most of the Palæozoic, the starfishes could have had no carnivorous enemies other than the cephalopods; as for marine fishes, the armoured Arthrodires did not appear until the Middle Devonic, while the ancient sharks were not common until Lower Carboniferous (Mississippi) time. It is possible that regeneration among the starfishes is connected with the rise of carnivorous enemies, but as the habit is so common among living forms it is more probable that this power has always been inherent in the class. Regeneration among the crinoids has been noted in several cases where lost distal ends of arms were being replaced by immature growths. Such have been seen in the Lower Carboniferous (Burlington and Keokuk formations) of America."

Mode of Life.—The rigid position in which the arms have been preserved, and the closely set ambulacralia, suggest that the arm had but little power of lateral or vertical movement. Bather (9A, pp. 451, 510) has already referred to the littoral and probably even arenaceous condition of the "Starfish bed." One of the commonest of recent Starfishes in a littoral arenaceous habitat is *Astropecten*, which has pointed feet by means of which it runs about the sandy bottom. It seems to me that *Cnemidactis* may have had a similar mode of life.

The condition of the mouth-parts suggests also that the creature fed just as does *Astropecten.* The rigid form of the mouth-rings and the trap-like nature of the tori of *Cnemidactis* are all in favour of this view. MacBride (43, p. 468) states that the "loss of suckers has rendered *Astropecten* and its allies incapable of feeding in the manner described in the case of *Asterias rubens.* They are unable forcibly to open the valves of shell-fish, and the only resource left to them is to swallow their prey whole. The mouth is consequently wide, and the unfortunate victims, once inside the stomach, are compelled by suffocation to open sooner or later, when they are digested."

Family Arthrasteridæ, nova.

Diagnosis.—Group C forms with adambulacralia much as in the Urasterellidæ. Infero-marginalia with paxilla-shaft in the form of a strong transverse ridge. "Single" interradial plates immediately distal to the primary circlet.

No previous attempt has been made to link up the forms described below with other Palæozoic Asterozoa. I have named the family after the Cretaceous genus *Arthraster*, which seems to have been the longest surviving genus exhibiting "Urasterellid" affinities. The forms in the family have the long arms, small disc, and large adambulacralia of the Urasterellidæ, but differ in the apical plates, which usually have paxilla-shafts in the form of a transverse ridge. Superficially similar Asteroidea with long arms and a small disc, such as *Odinia* and *Labidiaster*, also occur in the existing deep sea; but they have evolved along quite different lines and are probably of more recent origin.

There are at present only three genera belonging to the family, *Protarthraster* from the English Devonian, *Calliasterella* from the Russian Carboniferous, and *Arthraster* from the North-west European Cretaceous. The distinctions of the forms from one another and from the Urasterellidæ can best be seen from the following table:

	Urasterellidæ.	*Protarthraster.*	*Calliasterella.*	*Arthraster.*
	Apical.	Marginal.	Apical.	Marginal.
Infero-marginalia	Paxilla-shafts usually columnar, rarely as transverse ridges	Paxilla-shafts as transverse ridges	Paxilla-shafts as transverse ridges	Paxilla-shafts as transverse ridges.
Radialia .	Paxilla-shafts either ridge-like, boss-like, or columnar. If there are ridges they are not transverse, but run the length of the ossicles	Paxilla-shafts as transverse ridges	Paxilla-shafts as transverse ridges	Paxilla-shafts as transverse ridges.
Adradialia .	First row may have longitudinal ridges or all may have long columnar paxilla-shafts	First two rows with transverse ridges, remainder with short columnar paxilla-shafts	Not present	One row with transverse ridges.
	Proximal adradialia paired	Proximal adradialia single	Proximal adradialia single	Disposition of proximal adradialia not known.

The arrangement of the apical plates of the disc gives a clue to the ancestry of the forms within the Family.

Schöndorf regarded the "single" interradial plates of *Calliasterella* (Text-fig. 110, p. 167) as primary interradialia homologous to the similar plates of the Asteroidea of Section A. This cannot be, as the primary interradialia are always proximal to the primary radialia, whereas in this form the plates are distinctly distal. It seems much more reasonable to suppose that the plates have arisen from a suppression of one of each of the paired proximal adradialia of the Urasterellidæ, as is foreshadowed in *Salteraster ? coronella* (Text-fig. 90, p. 140), and that a circlet of primary interradialia is not present in *Calliasterella* just as is the case in *Urasterella*. The presence of the "single" interradial in *Protarthraster* is an important link between *Calliasterella* and the early "Urasterellid" forms. It is possible that when a disc of *Arthraster* can be examined it will have the same structure, for this genus obviously has close relationships with *Calliasterella*.

I have divided the family into three sub-families corresponding to the different genera. It may be that when further connecting links are known this sub-division may prove to be unnecessary.

1. Sub-family *Protarthrasterinæ*, nova.

Diagnosis.—Arthrasteridæ with many rows of apical plates. The inner rows have paxilla-shafts as transverse ridges. The outer rows have columnar paxilla-shafts.

Genus **PROTARTHRASTER**, novum.

Generic Characters.—As those of the sub-family.

1. **Protarthraster longimanus** (Whidborne). Plate XIII, figs. 3—5; Text-figs. 104—108.

1896. *Palæaster longimanus*, Whidborne, Proc. Geol. Assoc., vol. xiv, p. 376.
1898. „ „ „ Mon. Devonian Fauna S. England, vol. iii (Palæontogr. Soc.), pp. 204–215, pl. xxvi, figs. 1–4; pl. xxix, fig. 3.

Material.—Six specimens are known, four in the Museum of Practical Geology,

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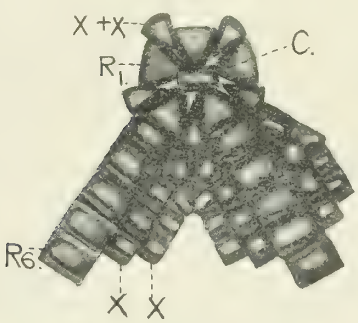

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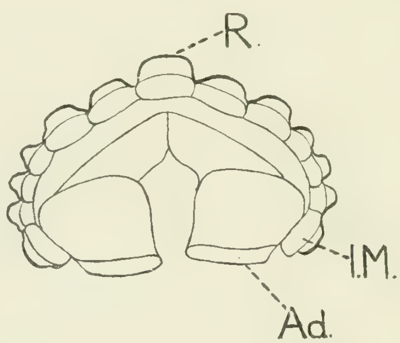


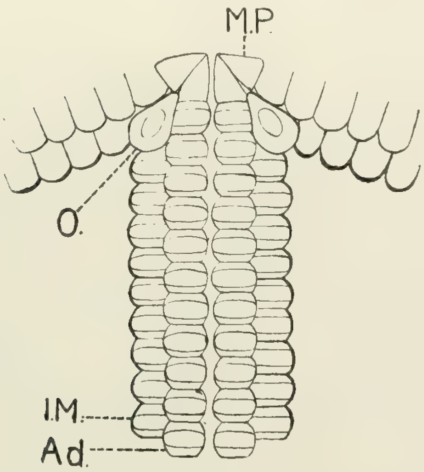
Text-fig. 104.—Wash drawing of a portion of the apical surface of *Protarthraster longimanus*. *C.*, centrale; *R.*, radialia; *X.*, adradialia of first and second series; *X.* + *X.*, fused adradialia (proximal interradial). × 6.
Text-fig. 105.—Cross-section through the arm of *Protarthraster longimanus*. *Ad*, adradialia; *I.M*, inferomarginalia; *R.*, radialia. × 20.

Jermyn Street. These include the holotype (7163 and its counterpart 7164) figured by Whidborne, pl. xxvi, figs. 1, 2, and figured here, Pl. XIII, figs. 3, 4, and in the Text-figures; specimen 7162 figured by Whidborne, pl. xxvi, fig. 3, and figured here, Pl. XIII, fig. 5, and two specimens not figured here nor by Whidborne. The remaining two specimens are in the Sedgwick Museum, Cambridge. They are both figured by Whidborne, pl. xxvi, fig. 4, and pl. xxix, fig. 3 respectively, and not re-figured here.

Holotype (Plate XIII, figs. 3, 4; Text-figs. 104—107).—The holotype is at first sight so different from the other specimens that it almost looks like another species. Its disc is raised and the arms stretched out in straight lines from it. Casts of the

apical surface show the position of the original ossicles very clearly (Text-fig. 104). Their position is almost diagrammatically simple. There is a distinct centrale which, like all the other apical plates, has a raised central area. Around the

106



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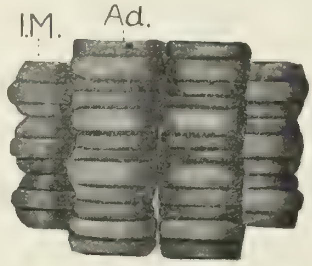


Text-fig. 106.—Plan of ossicles on the oral surface of *Protarthraster longimanus*. *Ad.*, adambulacralia; *I.M.*, infero-marginalia; *M.P.*, mouth-angle plates; *O.*, odontophor. × 12.
Text-fig. 107.—Wash drawing of a portion of the oral surface of *Protarthraster longimanus*. *Ad.*, adradialia; *I.M.*, infero-marginalia. × 18.

centrale are grouped five primary radialia forming a closed circle. In the interradial angles just distal to the primary radialia are five triangular plates which, as suggested above (p. 163), probably represent the fused pairs of adradialia from adjacent arms. The remaining adradialia are added in the same manner as in

Text-fig. 108.—Wash drawing of the mouth-angle plates of *Protarthraster longimanus*. *M.P.*, mouth-angle plate; *O.*, odontophor; *T.*, torus. × 8.

Urasterella. All the plates of the apical surface are closely touching without any interspaces for the protrusion of papulæ.

The paxilla-shafts of the radialia are drawn in Text-fig. 104 as being transverse ridges. This is as they appear on one arm. On other arms the paxilla-shafts of the proximal radialia appear to be knob-like as in *Salteraster ? coronella*. I am unable to say whether this appearance is natural or whether it is due to a destruc-

22

tion of former regular quadrilateral edges of the mould. The paxilla-shafts of the first and second rows of adradialia are always transverse ridges.

There are a further three rows of small adradialia, only seen in side view, carrying short columnar paxilla-shafts. Remains of the spines which were originally carried by the paxillæ are to be seen between and occasionally on the plates. I have not been able to identify a madreporite.

In oral view the infero-marginalia are clearly seen. They are not pushed on to the apical surface as in *Urasterella*. Each ossicle has a transverse ridge. The adambulacral ridges are also clearly seen. The mouth-angle plates are not very distinct in this specimen. There is a large ridged odontophor in each interradius.

Specimen from Baggy Point (Plate XIII, fig. 5; Text-fig. 108).—The arms in this position have been somewhat disturbed after death. The various views obtained enable me to add to the details given above. The mouth-angle plates are not as in *Urasterella*, but have a distinct proximal hollow which carried large and prominent spines. The groove is open in many portions of the arm. The adambulacralia are seen to be exactly as in *Urasterella*. The exposed ambulacralia are very similar to those of *U. ruthveni*. The left arm of the photograph shows a good side view of the three outer small rows of adradialia. These carry very short columnar paxilla-shafts.

The remaining specimens only confirm the details already given.

Measurements.—Specimen 7162 alone enables one to give the relative length of the major and minor radii; R : r : : 20 mm. : 2 mm. The holotype has r = 2 mm. The arms are broken off short. The specimen figured by Whidborne, pl. xxix, fig. 3, is about half the size of the above specimens.

Horizon and Locality.—Upper Devonian (Pilton Beds) of North Devon.

2. Sub-family *Calliasterellinæ*, nova.

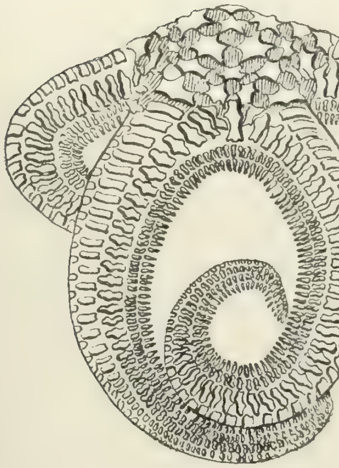
1910. *Calliasteridæ*, Schöndorf, Jahrb. nassauisch. Ver. Naturk., Wiesbaden, vol. 63, p. 251.
1914. *Calliasterellidæ*, Schuchert, Fossilum Catalogus, Animalia, pt. 3, p. 7.
1915. „ Schuchert, Bull. 88, U.S. Nat. Mus., pp. 162, 163, 190.

Diagnosis.—Arthrasteridæ with three rows of apical plates (one row of radialia and two rows of infero-marginalia). These rows have paxilla-shafts in the form of strong transverse ridges. Odontophor with strongly indented sides.

The sub-family does not contain any known British species. Its one representative, *Calliasterella mira*, Trautschold, from the Russian Carboniferous, occurs at the same horizon and locality as *Urasterella montana* (see p. 147). A full description of the form was given by Schöndorf (65, pp. 327—337, pl. xxiii, figs. 2—5, pl. xxiv, figs. 1—18), who thought that the form was a Cryptozonate

Asteroid. The Text-figures given here are taken from this paper, and they illustrate the real affinities of the form.

109



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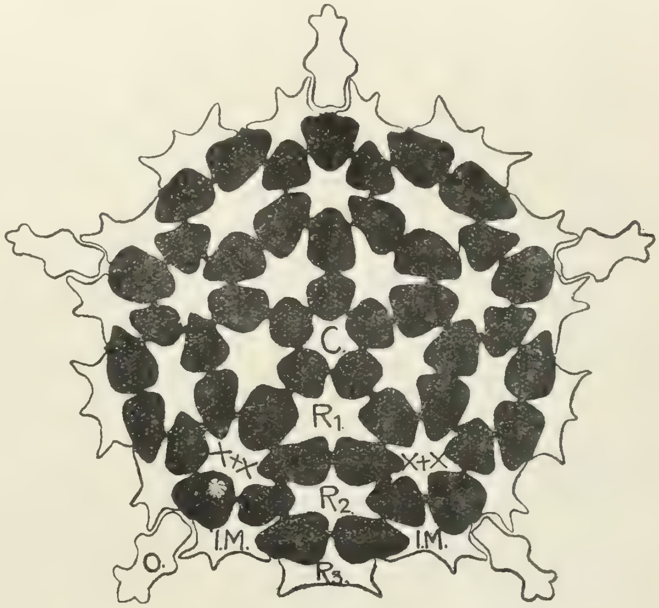

TEXT-FIG. 109.—Reconstruction of *Calliasterella mira* (after Schöndorf). × ¾.
TEXT-FIG. 110.—Plan of the ossicles on the disc of *Calliasterella mira* (after Schöndorf). *C.*, centrale; *I.M.*, infero-marginalia; *O.*, odontophor; *R.*, radialia; *X.* + *X.*, fused adradialia (proximal interradial). × 1·5.

Text-fig. 109 shows the small disc, long arms, and prominent odontophor, and all these features indicate a close relationship with the Urasterellidæ. The

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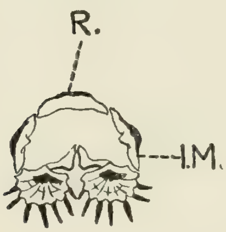

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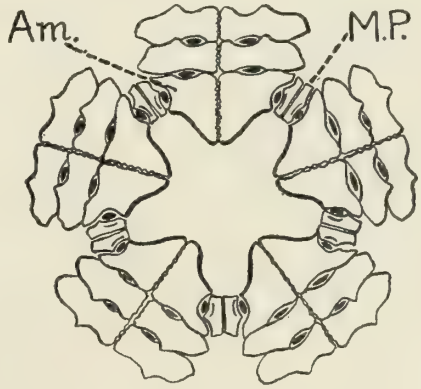

TEXT-FIG. 111.—Cross-section through the arm of *Calliasterella mira* (after Schöndorf). *I.M.*, inferomarginalia; *R.*, radialia. × 1·4.
TEXT-FIG. 112.—Plan of ossicles in the mouth-region of *Calliasterella mira* (after Schöndorf). *Am.*, ambulacral; *M.P.*, mouth-angle plate.

rounded arms rolled up ventrally present, as Schöndorf noted, a strong superficial resemblance to the American Carboniferous Ophiuroid *Onychaster flexilis*, Meek

and Worthen. I have already noted (p. 150) a somewhat similar method of preservation of the English species *Salteraster asperrimus* and the American species *Urasterella grandis.* It is probably due to a strong contraction of the interadambulacral muscles after death, and indicates the powerful character of these muscles (see p. 133).

Text-fig. 110 is a plan of the ossicles on the apical surface of the disc relettered so as to show its correspondence with a similar plan of the same region in *Protarthraster* (Text-fig. 104, p. 164). The prominent odontophor is much more exposed than in *Protarthraster*, and reminds one of the similar ossicle in *Cnemidactis* (compare with Text-fig. 101, p. 157).

Text-fig. 111 shows "Urasterellid" adambulacralia with long spines. Schöndorf (*op. cit.*, p. 332) describes the proximal (adoral) surface of the adambulacralia as being concave and the distal (aboral) surface as being convex. I am inclined to believe after examination of Schöndorf's figures that the muscle-attachments are merely a modification of those described for *Urasterella thraivensis* (p. 133). No adambulacral ridges have been described. The adambulacral armature is, however, very similar to that of *Urasterella* (compare Pl. VIII, fig. 3). It is just possible that very reduced adambulacral ridges may be present, as in *Urasterella montana* (p. 148). The body-cavity as depicted by Schöndorf is much larger than in any of the Urasterellidæ.

Text-fig. 112 shows the general resemblance between the mouth-parts of the form and those of *Urasterella.* The Text-figure should be compared with fig. 4 of Pl. VIII.

Sub-family *Arthrasterinæ*, nova.

1907. *Arthraster* (family uncertain), Spencer, Mon. British Foss. Echinoderm., Cretaceous (Palæontogr. Soc.), vol. ii, p. 91.
1913. „ „ Spencer, Phil. Trans. Roy. Soc., vol. cciv B, p. 139.

Diagnosis.—Arthrasteridæ with five rows of apical plates (one row of radialia, two rows of adradialia, and two rows of infero-marginalia). These rows have paxilla-shafts in the form of strong transverse ridges. Arrangement of the apical plates of the disc and the mouth-parts not known.

The Sub-Family contains one genus, *Arthraster*, with two species, *A. dixoni*, Forbes, and *A. cristatus*, Spencer. Both species are found in the Chalk of N.W. Europe. I am dealing briefly with this genus here although it has no known Palæozoic representative. It is convenient, however, to place the forms at least in relationship with other Asterozoa.

PLATE VI.

Fig.		Page.
1.	*Uranaster ramseyensis* (Hicks); photograph of oral surface, × 3.—Lower Ordovician (Arenig); Ramsey Island. Lightbody Collection, University Museum, Manchester, no. L. 11036 *a* . .	110
2.	Ditto; photograph of apical surface, × 3.—Ibid.; no. L. 11038 .	109
3.	Ditto; photograph of oral surface, × 3.—Ibid.; no. L. 11036 *b* .	110
4.	Ditto; photograph of apical surface, × 3.—Ibid.; no. L. 11037 .	109
5.	*Lepidactis wenlocki*, n. sp.; × $1\frac{1}{2}$; photograph of oral surface.—Middle Silurian (Wenlock); Dudley. British Museum (Nat. Hist.), no. 57426; *M.*, madreporite	113
6.	*Lepidaster grayi*, Forbes, × 3 (approximately).—Ibid. Ketley Collection, University of Birmingham, no. 221. . . .	121

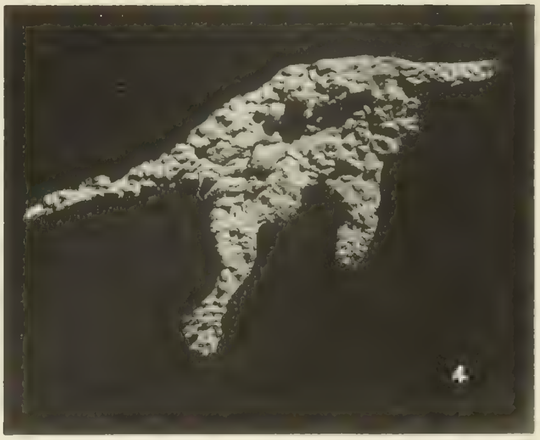

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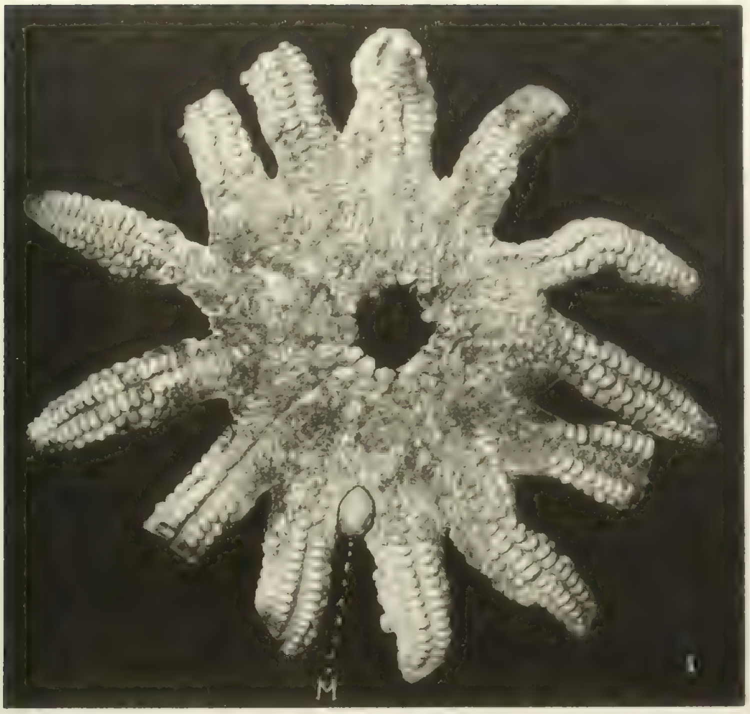
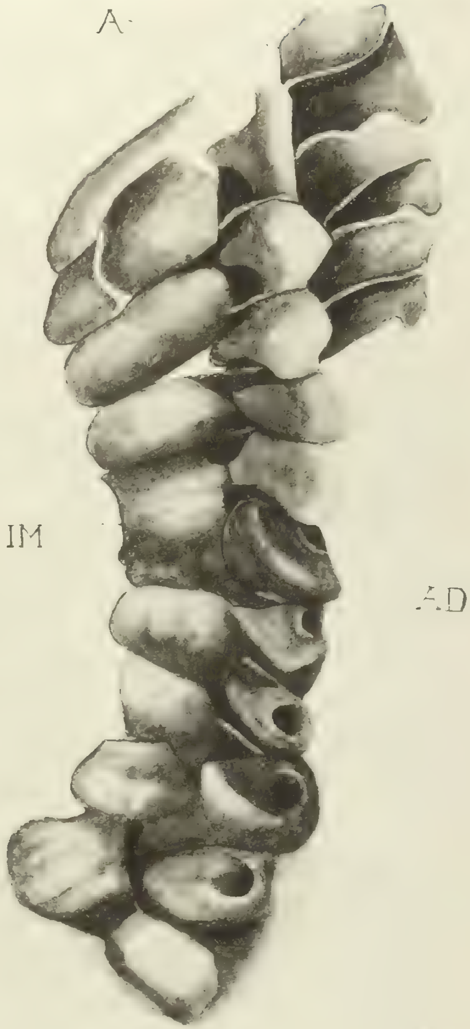
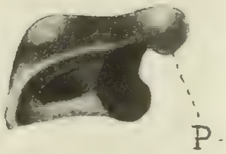
PLATE VII.

Fig.		Page.
1.	*Lepidaster grayi*, Forbes; photograph of oral surface, $\times 1\frac{1}{2}$ to 2 (approx.).—Middle Silurian (Wenlock); Dudley. Museum of Practical Geology, Jermyn Street, no. 27515; *M.*, madreporite	117
2.	Wash drawing of a portion of arm of same specimen. $\times$ 10 (approx.). *A.*, ambulacral; *Ad.*, adambulacral; *I.M.*, inferomarginal	118
3.	Wash drawing of a pair of mouth-angle plates of the same specimen showing also the torus with some of its spines, $\times$ 10	118
4.	Side view of an adambulacral from the same specimen, $\times$ 10. *P.*, point of attachment of the adambulacral with a ventro-lateral	119
5.	Wash drawing of a model of three adjacent proximal adambulacralia of the same specimen, $\times$ 10 (approx.). *R.*, ridge of adambulacral; *P.*, point of attachment of the adambulacral with a ventro-lateral	119
6.	Photograph of another individual of the same species, $\times \frac{3}{5}$. Ibid. Dudley Museum, no. 606	120







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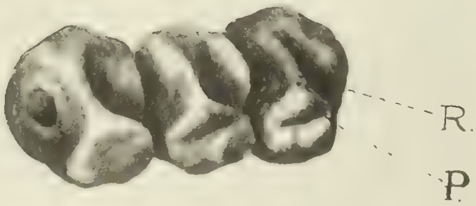

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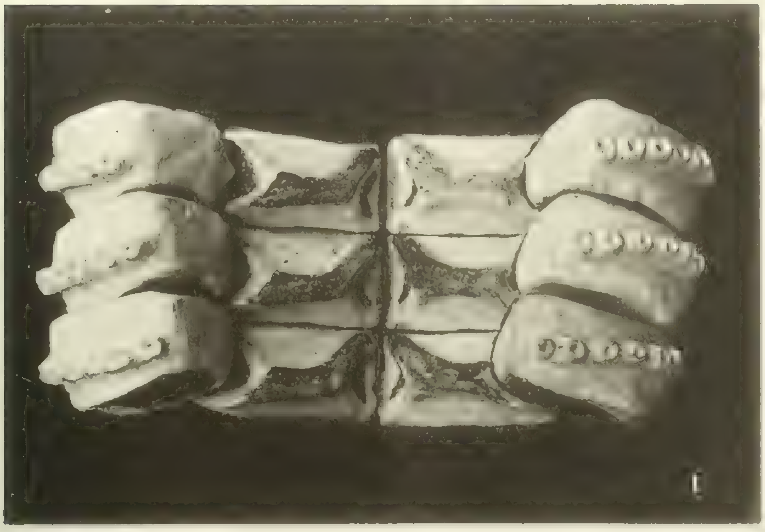
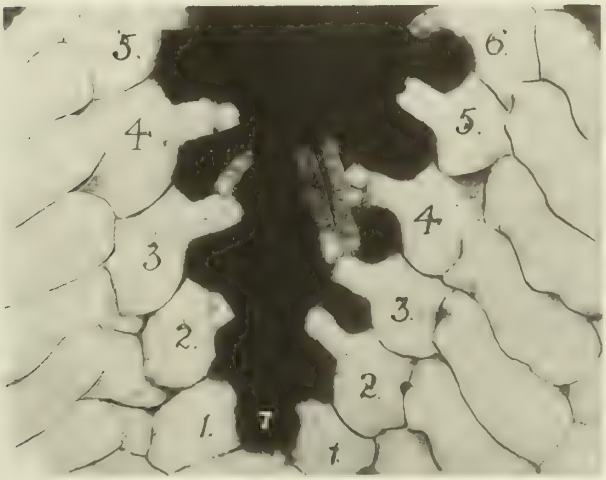
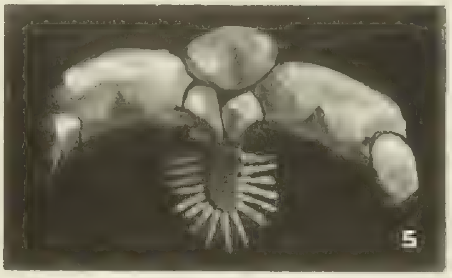
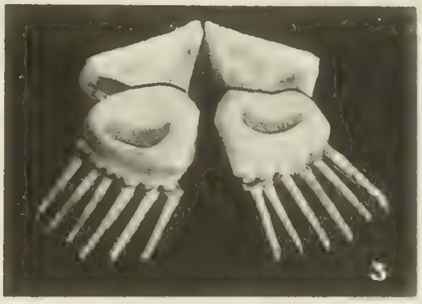
PLATE VIII.

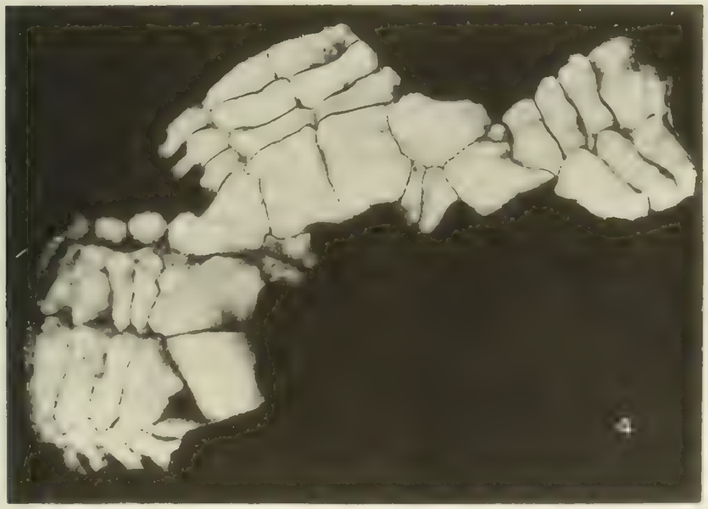
Fig.		Page.
1.	*Urasterella thraivensis*, n. sp.; photograph of a model of a small portion of the ambulacral groove, × 10.—Upper Ordovician (Ashgillian); Thraive Glen, Ayrshire. A key to this photograph is given, Text-fig. 83, p. 132	131
2.	Photograph of the right half of the same model taken in a direction facing the wall of the groove. The ossicles are seen tipping towards the mouth, as also does the muscle depression on the outer extremity of each ambulacral	132
3.	Photograph of ossicles of the same model taken so as to show the ambulacral groove in vertical cross-section . . .	133
4.	*Urasterella medusa*, Hudson; photograph of the mouth-region in apical view, × 10 (from a photograph supplied by Hudson) . .	135
5.	*Cnemidaster girvanensis* (Schuchert); photograph of a model of the mouth-region in apical view, × 7	135
6.	Photograph of the same model showing the oral surface as seen from within the mouth. A key to this photograph is given, Text-fig. 103, p. 160	135
7.	*Urasterella medusa*, Hudson; photograph of portion of the apical surface of two arms to show the paxilliform infero-marginalia, × 20 (after Hudson). Pores for papulæ (?) are also seen on the inner side of the infero-marginals 2 and 3 on the right arm . . .	130











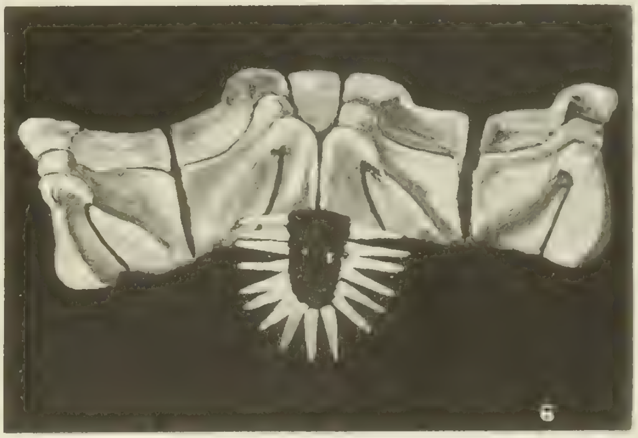


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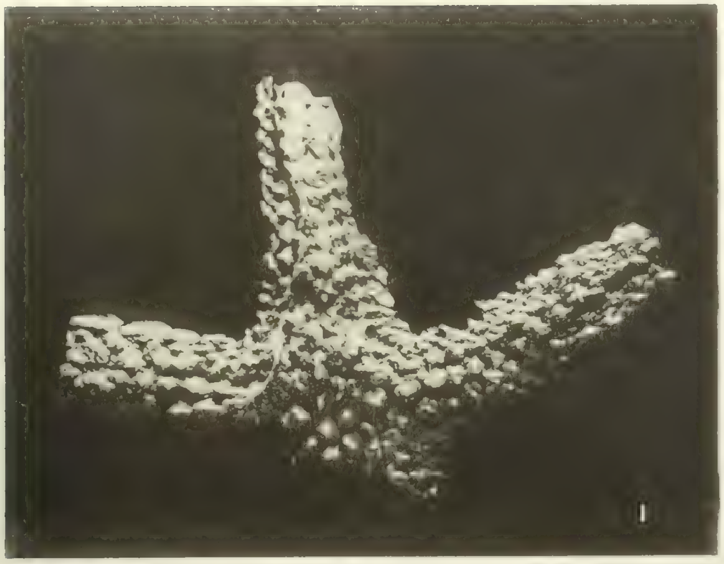
PLATE IX.

Fig.		Page.
1.	*Urasterella thraivensis*, n. sp.; photograph of apical surface of disc, × 5.—Upper Ordovician (Ashgillian); Thraive Glen, Ayrshire. Mrs. Gray's Collection, no. D. 111	137
2.	Photograph of the oral surface of another specimen of the same species, × 3.—Ibid. Mrs. Gray's Collection, no. D. 254	138
3.	*Urasterella ruthveni* (Forbes), var. *leintwardinensis*, nov.; photograph of the apical surface, × 3.—Upper Silurian (Lower Ludlow); Leintwardine, Herefordshire. Ludlow Museum, no. iv	143
4.	The same specimen, × 6	143
5.	*Urasterella ruthveni* (Forbes); photograph of lateral view of arm, × 4.—Upper Silurian (Ludlow); Bannisdale Slates, N. End of Benson Knot. Sedgwick Museum, Cambridge	140



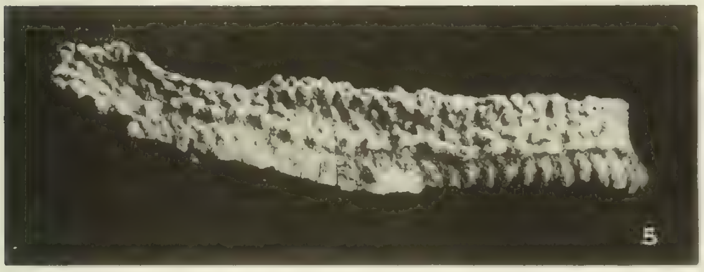


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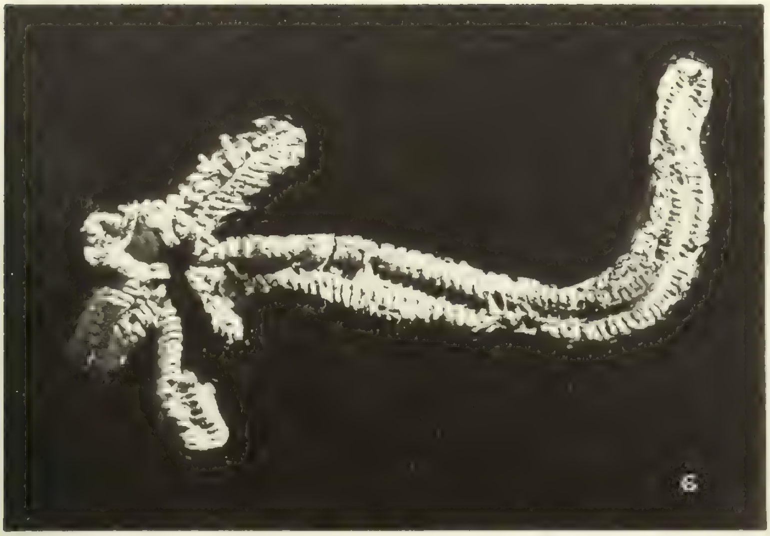
PLATE X.

Fig. Page.

1. *Urasterella thraivensis*, n. sp.; photograph of the oral surface of a portion of an arm, × 4.—Upper Ordovician (Ashgillian); Thraive Glen, Ayrshire. Mrs. Gray's Collection, no. D. 35 . . 138
2. *Urasterella gutterfordensis*, n. sp.; photograph of the apical surface, × 2.—Middle Silurian (Wenlock); Gutterford Burn, Pentland Hills. Royal Scottish Museum, no. 93 . . . 144
3. Photograph of the oral surface of the counterpart of the previous specimen, × 4. Royal Scottish Museum, no. 67 . . 145
4. *Urasterella ruthveni* (Forbes); photograph of the oral surface, × 2.—Upper Silurian (Ludlow); Bannisdale Slates, High Thorns, Underbarrow. Sedgwick Museum, Cambridge, no. *a*. 920 . . 141
5. Ditto; photograph of oral surface, × 4.—Ibid. Sedgwick Museum, Cambridge, no. *a*. 510 141
6. Ditto; photograph of the oral surface, × 2.—Upper Silurian (Ludlow); N. End of Benson Knot. Sedgwick Museum, Cambridge . 141



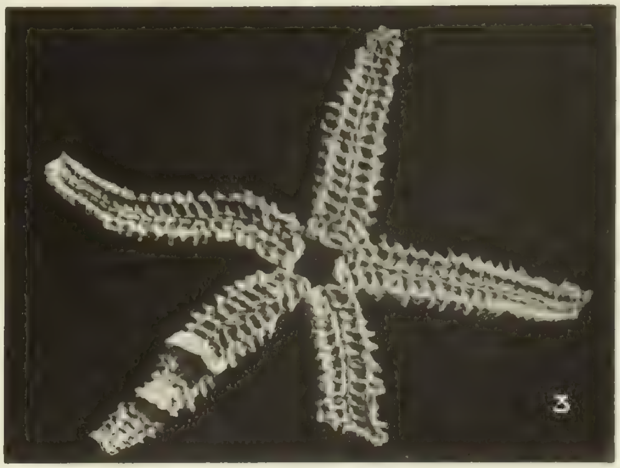


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PLATE XI.

Fig.		Page.
1.	*Cnemidactis girvanensis* (Schuchert); photograph of apical surface, × 2.—Upper Ordovician (Ashgillian); Thraive Glen, Ayrshire. Mrs. Gray's Collection, no. D. 216	159
2.	Ditto; photograph of oral surface, × 2.—Ibid. Mrs. Gray's Collection, no. D. 24 *c*	159
3.	*Salteraster asperrimus* (Salter); photograph of the apical surface, × 2.—Upper Ordovician (Caradocian); Quakers' Burial Ground, Welshpool. Museum of Practical Geology, Jermyn Street, no. 7435	150
4.	Photograph of the counterpart of the same specimen, × 2 . .	150
5.	*Salteraster* (?) *imbricatus* (Salter); photograph of the apical surface, × 4.—Upper Ordovician (Caradocian); Llanfyllin, Montgomeryshire. Museum of Practical Geology, Jermyn Street, no. 28364 .	152
6.	*Salteraster* (?) *coronella* (Salter); photograph of the apical surface, × 4.—Lower Silurian (Upper Llandovery); Gunwick Mill, near Africk. Museum of Practical Geology, Jermyn Street, no. 7402 .	153
7.	*Urasterella pulchella*, Billings; photograph of the mouth-region in oral aspect, × 10.—Middle Ordovician (Trenton); Ottawa, Canada. Victoria Memorial Museum, Ottawa, no. 1397. The photograph was sent to me by Dr. Hudson	135
8.	Ditto; photograph of the adambulacralia of the same species turned slightly on one side (after Hudson) × 10 . . .	134

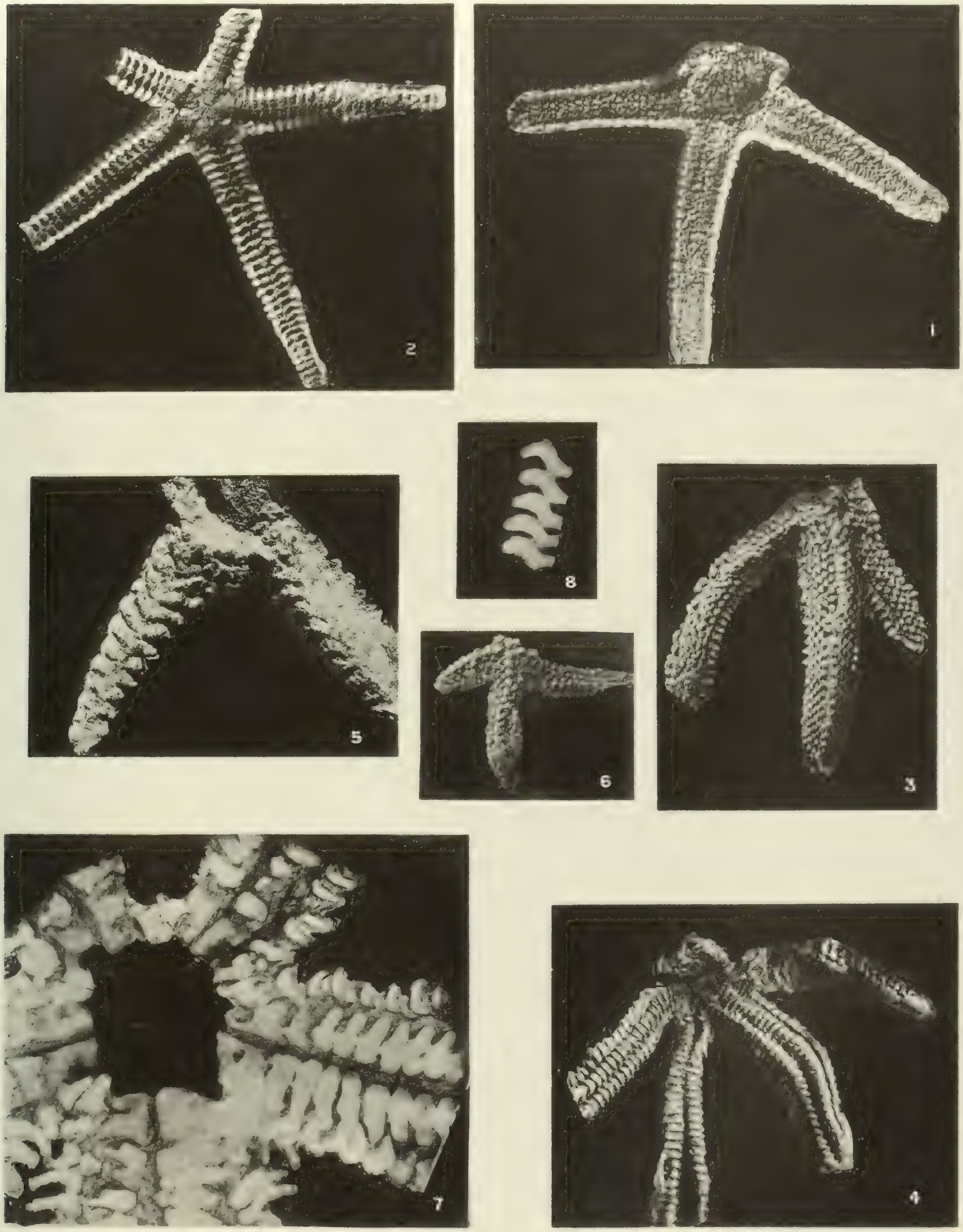

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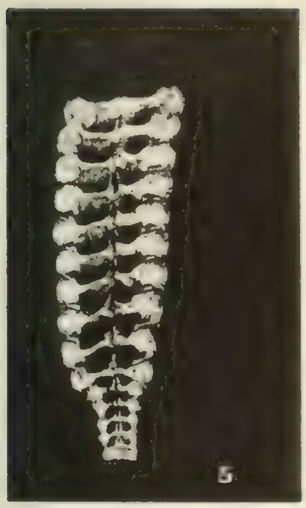
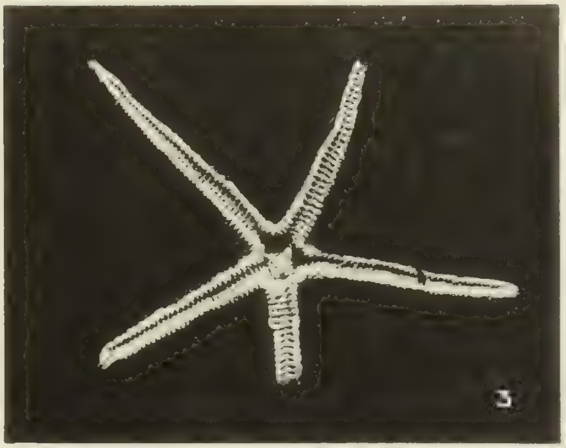
PLATE XII.

Fig.		Page.
1.	*Cnemidactis girvanensis* (Schuchert); photograph of the apical surface to show the linear arrangement of the paxillæ and the upper surfaces of the exposed ambulacralia, × 2.—Upper Ordovician (Ashgillian); Thraive Glen, Ayrshire. Mrs. Gray's Collection, no. D. 218	158
2.	Ditto; photograph of the apical surface taken at a slightly different angle, × 3.—Ibid. Mrs. Gray's Collection, no. D. 73. *O.*, odontophor	159
3.	Ditto; photograph of the oral surface to show the spoke-like arrangement of the arms, nat. size.—Ibid. Mrs. Gray's Collection, no. D. 218 *c*.	159
4.	Ditto; photograph of the oral view of a portion of one arm to show the ornament on the adambulacralia and the ridges on the ambulacralia, × 3.—Ibid. Mrs. Gray's Collection, no. D. 73 *c* .	157
5.	Ditto; photograph of the extremity of an arm to show regeneration, × 4.—Ibid. Mrs. Gray's Collection, no. D. 110 *c* . .	161





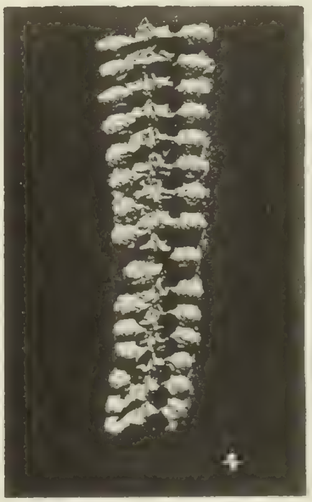


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PLATE XIII.

Fig.		Page.
1.	*Onemidactis girvanensis* (Schuchert); photograph of the apical surface of a young specimen, × 6.—Upper Ordovician (Ashgillian); Thraive Glen, Ayrshire. Mrs. Gray's Collection, no. D. 255 .	161
2.	Photograph of the side view of an arm of an older individual of the same species, × 3. Ibid.—Mrs. Gray's Collection, no. D. 125 .	157
3.	*Protarthraster longimanus* (Whidborne); photograph of the apical surface, × 5.—Upper Devonian; near Braunton, Devon. Museum of Practical Geology, Jermyn Street, no. 7163 . .	164
4.	Photograph of the oral surface of the same specimen, × 4 . .	164
5.	Ditto; photograph of the oral surface of another individual from the same horizon at Baggy Point, N. Devon, × 4.—Museum of Practical Geology, Jermyn Street, no. 7162 . . .	166

5

1

2

4

3

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Palæontographical Society, 1916.

A MONOGRAPH

OF

BRITISH GRAPTOLITES.

BY

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1901.
Strandmark, J. E.,
"Undre Graptolit-skiffer vid Fågelsång,"
'Geol. Fören. Förh.,'
vol. 23, pp. 548–556,
pl. xvii.

The author gives a description of the so-called "Lower Graptolite Shales" of Fågelsång, noting the lithological and palæontological sequence. He figures (taf. 17) the species *Tetragraptus Bigsbyi*, Hall, and *Tetragraptus phyllograptoides*, Linnrs., and also a remarkable new form, **Phyllograptus cor** Strandmark, and discusses their probable phylogenetic inter-relationships.

1901.
Elles and Wood,
"Monograph of British Graptolites." (Edited by Chas. Lapworth.)
pt. 1, pp. 1–54.
Palæontographical Society, 1901.

The Monograph opens with a brief Introduction by the Editor, giving an account of the origin, object, and plan of the work and of the mode of illustration. The First Part is devoted to the description and figuring of the British forms assigned to the Genus *Didymograptus* of the family of the Dichograptidæ. The illustrations include quarto plates (I—IV), in which the species are represented on the natural scale, and Text-figures (1—35), in which minor details are given on a scale of five times the natural size. Some twenty-eight species are described, of which the following are noted as new: *Didymograptus* **uniformis,** *D.* **similans,** *D.* **deflexus,** *D.* **amplus,** *D.* **artus,** *D.* **stabilis,** and *D.* **acutidens** (Lapw. MS.).

The Descriptive Section is prefaced by short definitions of the morphological terms employed, and a synopsis of the several groups of *Didymograptus* recognised. At the close of the description of each such group the individual characteristics of its component forms are tabulated and compared.

1901.
Malaise, C.,
"Etat actuel de nos connaissances sur le Silurien de la Belgique," 'Annales Soc. Geol. du Nord,'
vol. xxx, pp. 188–190.

The author summarises the results of his long-extended and successful researches into the geology and fossils of the Cambrian, Ordovician, and Silurian deposits of the Massif of Brabant, and the Band of Sambre and Meuse, and gives a generalised scheme of the sequence in each area. Especial attention is directed to the close parallelism between the British and Belgian palæontological succession, and to the recognised presence of the same characteristic forms of Graptolites in several corresponding horizons in the two countries.

1901.
Kerforne, F.,
"Silurique de la presqu'ile de Crozon (Finistere)," Rennes, 1901, pp. 1–230.

An account of the author's study of the Silurian Succession in the peninsula of Crozon, with lists of the fossils detected. Seven successive Graptolite Zones are recognised, ranging from the equivalents of the British Upper Llandovery to those of the Lower Ludlow, both inclusive. Some nineteen forms of Graptolites are distinguished as present, and their horizons indicated.

1901.
Eisel, R.,
"Zonenfolge ost Thüringischer und Vogtländischer Graptolithenschiefer," 'Jahrb. Gesell. Freund. Naturwissenschaften in Gera,' year 1900.

This Memoir is remarkable as being the first to demonstrate the fact that the zonal succession of Graptolite species in Central Germany corresponds closely with that already established in Britain and North-West Europe. It is the fruit of the enthusiastic researches of the author carried on for many years into the chronological succession of Graptolite species in the Thuringian areas, long previously rendered classic by the works of Geinitz and Richter.

The author makes known the presence of several successive Graptolite zones in the sequence described, which ranges from Middle Llandovery to Lower Ludlow, and gives the names and ranges of the forms collected by himself personally. The zones described are distinguished by the author by names derived from their characteristic local species, and the following forms are given as new: *Monograptus* **priodon**, var. **reductus**; *M.* **veles**; *M.* **Sedgwickii**, var. **Voglandicus**; *Diplograptus* **binodosus**; *D.* **juncus**; *D.* **Thuringiacus**; *Retiolites* **præcursor**; *Climacograptus* **citrocrescens**; *Dimorphograptus* **Lapworthi**. (See also Törnquist, 1887.)

1901.
Ruedemann, R.,
"Hudson River Beds near Albany, and their Taxonomic Equivalents," 'New York State Mus.,' Bull. 42.

A summary of the author's discoveries among the complicated Graptolite-bearing strata of the Hudson River Valley.

CHAPTER V.

1902 to 1913.

1902.
Moberg, J. C.,
"Didymograptus Skiffer," 'Geol. Fören. Förh.,' vol. 24, pp. 44–48.

The author proposes to unite under the single title "Didymograptus Skiffer" all the Scandinavian Graptolite-bearing strata ranging from the horizon where *Didymograptus* makes its earliest appearance to the top of the *Didymograptus geminus* beds.

1902.
Elles and Wood,
"Monograph of British Graptolites," pt. 2, Palæontographical Society, 1902.

This Second Part of the British Monograph opens with the first two chapters of the promised "General Section." These chapters (pages i to xxviii) treat of the History of Research among the Graptolites in general from the times of Bromell and Linnæus (1727) to those of Barrande (1850) and Scharenberg (1851). References are made to the titles and dates of publication, etc., of the several Memoirs cited, and a synopsis is given of the more important facts and deductions brought forward by each author.

This "General Section" is followed (pp. 55–102) by the continuation from Part I. of the "Descriptive Section." It treats of the whole of the British species

assigned to the family of the Dichograptidæ, with the exception of those belonging to the genus *Didymograptus* (already described in Part I). Twelve British genera are recognised (including *Phyllograptus*, previously regarded by many authorities as constituting a distinct family, and *Azygograptus*, hitherto assigned to the Leptograptidæ). Four new species are described and figured: *Tetragraptus* **reclinatus,** *T.* **Postlethwaitii,** *T.* **Amii** (Lapw. MS.), *Holograptus* **Deani** (Lapw. MS.), and *Bryograptus* **divergens.**

1902.
Kerforne, F.,
"Gothlandien inférieur du Massif Armoricain," 'Comptes Rendus, Acad. Sciences,' July 15, 1902.

An outline description of the lithological divisions of the Llandovery and Tarannon strata of Anjou, etc., with a note on their included Graptolites.

1902.
Ruedemann, R.,
"Graptolite Facies of the Beekmantown Formation in Renesslaer County," "New York State Palæontol. Ann. Rept.," 'New York State Mus.,' Bull. 52, p. 546.

A registration of the progress and results of the author's researches and discoveries among the Graptolite-bearing Lower Palæozoic Strata of the State of New York. (See also "Upper Cambrian Horizon of *Dictyonema flabelliforme* in New York," "New York State Palæontol. Ann. Rept.," 'New York State Mus.,' Bull. 69, p. 934, 1903.)

1902.
Ruedemann, R.,
"Growth and Development of *Goniograptus Thureaui*," 'Bull. 52, New York State Museum,' pp. 576, etc.

An account of the discovery of two forms of *Goniograptus* (*Goniograptus Thureaui*, M'Coy, and *Goniograptus sp.*) in the Deep Kill Graptolite Beds of New York, with a discussion of the bearing of the structural details and successive ontogenetic stages in *Goniograptus* upon the phylogeny of the Graptolites in general.

1904.
Ami, H. M.,
"Preliminary List of Fossils collected by Prof. L. M. Bailey from localities in New Brunswick," 'Summary Rept., Geol. Surv., Canada,' 1904.

Identification of genera and species of Graptolites collected from the Lower Palæozoic Strata of New Brunswick, with notes of correlation of the containing beds.

1902.
Hall, T. S.,
"Reports on Graptolites," 'Records Geol. Surv. Victoria,' vol. i, pp. 33–35.

A revision of the Graptolite species from Eastern Victoria. A list of all the forms recognised up to date is included with localities. Two new species, *Didymograptus* **ovatus** and *Glossograptus* **Hermani,** are described and figured.

1903.
Elles and Wood,
"Monograph of British Graptolites," pt. 3. Palæontographical Society, 1903.

The General Section of this Third Part of the British Monograph continues the History of Research from 1851 to 1865; and the Descriptive Section is devoted to the British forms of the family of the Leptograptidæ. Four British genera—namely, *Leptograptus*, *Pleurograptus*, *Amphigraptus*, and *Nemagraptus* (*Cænograptus*)—are recognised, embracing eleven species with several varieties. Four of the species are given as new, viz. *Leptograptus* **latus,** *L.* **sacendens,** *L.* **validus** (Lapw. MS.), *L.* **grandis** (Lapw. MS.). In this, as in other parts of the work, the detailed descriptions are preceded by a summary of the general characteristics of the family or group under notice.

1904.
Noel, M. C.,
"Faune des Lydiennes du grés Vosgien," 'Comptes Rendus, Acad. Sciences,' June 13, 1904.

A list of the Graptolites discovered by Dr. Blücher (1898) and the author (1898—1915) in the pebbles of the Conglomerates of the 'Grés des Vosges' of the higher parts of the basin of the Meuse and the Moselle. Sixteen forms are noted, ranging from Llandovery to Lower Ludlow inclusive.

1904.
Elles, G. L.,
"Some Graptolite Zones in the Arenig Rocks of Wales," 'Geol. Mag.' dec. v, vol. i, pp. 199-211.

The author summarises the results of her personal studies in the field and in the laboratory of the Vertical Distribution of the recognisable species of Graptolites occurring in Sedgwick's "Arenig" Series of his type area and their equivalents in other parts of Wales. The rock-successions and Graptolite-sequences, as developed in the Arenig District, in Cærnarvon, in the Lleyn Peninsula, at St. David's, Abereiddy, Whitesand Bay, and other areas in South Wales, are described. These are correlated with the corresponding successions in Shropshire, the Lake District, and Scania. She concludes that three successive Graptolite Zones are distinguishable in these British Arenig strata, namely, the Zones of (1) *Didymograptus extensus*, Hall; (2) *Didymo. hirundo*, Salter; and (3) *Didymo. bifidus*, Hall. The oldest of these zones follows in order of time the *Dichograptus* Beds of the Lake District, whilst the newest graduates upwards into the sub-formation usually termed the Lower Llandeilo, which is characterised by the presence of *Didymograptus Murchisoni*. The '*Murchisoni* Zone' and the underlying '*Bifidus* Zone' are both marked by the dominance of "tuning-fork" Graptolites, and constitute the Llanvirn Series of Dr. Hicks.

1904.
Elles and Wood,
"Monograph of British Graptolites," pt. 4. 'Palæontographical Society,' 1904.

In this Fourth Part of the British Monograph the Historical Section is carried on from 1865 to 1871. The Descriptive Section deals with the British forms assigned to the family of the Dicranograptidæ. Of these only two genera are recognised, *Dicellograptus*, Hopkinson, and *Dicranograptus*, Hall. Thirteen British species are assigned to the former genus and ten to the latter.

The species described as new are *Dicellograptus* **angulatus,** *Dicranograptus* **brevicaulis,** *D.* **celticus,** *D.* **cyathiformis,** and *D.* **tardiusculus** (Lapw. MS.).

1904.
Hall, T. S.,
"Reports on Graptolites," 'Records Geol. Surv. Victoria,' vol. i, pp. 217–219.

Identifications and lists of Graptolite species from several localities in Victoria.

1904.
Törnquist, S. L.,
"Graptolites of the Lower Zones of the Scanian and Vestrogothian *Phyllo-Tetragraptus* Beds," pt. 2, 'Lunds Universitets Årsskrift,' vol. 40, pp. 1-29, pls. i–iv.

In this paper, of which the first part was published in 1901, Prof. Törnquist completes his figures and descriptions of the Graptolites of the Swedish strata corresponding broadly to the Arenig strata of Britain. The paper is marked throughout by the author's usual modesty of presentation, his care for accuracy of detail, and the beauty and clearness of his figures. There are four quarto plates, and an appendix showing the vertical distribution of the Graptolites described in the two parts of the Memoir. The Swedish species noted are about forty in number and are grouped in four successive zones named by the author. One genus is given as new (**Anthograptus**), and eight species—namely, *Bryograptus* **simplex,** *Tetragraptus* **Vestrogothus,** *Dichograptus* **regularis,** *Anthograptus* **crinitus** (Moberg, MS.), and *Azygograptus* **validus** (Moberg, MS.).

In a note in the body of the work Törnquist treats of the extreme difficulties in the classification of the so-called genera and species of the compound forms of the Dichograptidæ in general, and gives a provisional classification of those referred to in his own Memoirs. He expresses his agreement with Wiman and Ruedemann, that there can be "no fundamental difference between the 'dichotomous' and 'lateral' mode of division of the stipes," but notes at the same time the remarkable constancy of the one or the other mode in certain forms.

1904.
Törnquist, S. L.,
"Sundry Geological Notes," nos. 2 and 3, 'Geol. Fören. Förhandl.,' vol. 28, pp. 497—515.

In the second of these notes the author expresses his agreement with W. C. Brögger (1896) in regarding the Swedish Ordovician as commencing with the *Dictyonema* Shales (Tremadoc), and embracing three main members: (1) *Dictyonema* Shales; (2) *Didymograptus* Shales; and (3) *Dicellograptus* Shales. In the third note he discusses the synonymy of *Didymograptus gibberulus*, Nicholson; *Didymo. patulus*, Hall, and *D. constrictus*, Hall.

1904.
Ruedemann, R.,
"Graptolites of New York, Part I; Graptolites of the Lower Beds." 'New York State Museum, Memoir 7.'

This Memoir constitutes the first volume of a comprehensive Monograph by the author dealing with the Graptolites of New York State and their relations to those of the equivalent Graptolite-bearing regions elsewhere in the United States, in Canada, Europe, Britain, and Australia.

This first volume includes not only a description and illustration of all the

forms of Graptolites hitherto collected from the "Upper Cambrian" (Tremadoc) and "Lower Ordovicic" (Arenig) of New York State (the majority of which were the fruits of the author's long-extended personal field researches), but embraces also a detailed account and discussion of Graptolitic literature, knowledge, and speculation up to the date of publication.

The volume may be said to be divisible into two main sections: a first (pp. 498—577), treating of the Graptolites in general, and a second (pp. 577—783), devoted to the description of the New York forms.

The General Section opens with an outline Bibliography ranging from 1874 to 1903. This is followed by paragraphs dealing with the History of Research among the Graptolites, in which the difficulties of the various branches of the subject are pointed out, and the past stages of advance in knowledge and speculation adduced and frankly discussed. In sub-section 3 the author, after passing in review the methods of previous observers, describes the modes of illustration adopted, which on the whole are similar to those followed in the present work.

In sub-section 4, where Ruedemann is dealing with Terminology, he notes his adoption of Törnquist's term "rhabdosome" instead of polypary as the equivalent of the term "hydrosome" or the whole colony in the terminology of the "Hydrozoans," and suggests the new title "synrhabdosome" for each of those stellate assemblages which have been interpreted by himself as colonies of colonies. He calls attention to Lapworth's use (1897) of the term "graptotheca" as the equivalent of "hydrotheca," but follows the general procedure in using the simple term "theca" without qualification. He regards the Graptolites as being separable into the two orders of the Dendroidea (Nich.) and the Graptoloidea (Lapw.) and the latter as being divisible into the two sub-orders, viz. Graptoloidea-Axonolipa (Frech. Ruedemann, em.) and Graptoloidea-Axonophora (Frech.).

He draws a sharp distinction between the filiform tubular structure in the Axonolipa, termed by Lapworth the "nema" or "nemacaulus," and the solid axis, rod or "virgula" of the Axonophora, agreeing with those who hold that the latter is wanting as such in the Axonolipa, but is apparently present inside the nemacaulus in the polypary of the Diplograptidæ, etc. He employs Hall's term "funicle" for the common base of the component nemacauluses in the stellate forms.

After describing and illustrating the sicula and its relations, as worked out by the Swedish authorities, he expresses his full accord with those who hold that notwithstanding its resemblance to an ordinary serial theca it is always appropriate to designate by the special title "sicula" alone.

The various classifications of the Graptoloidea are passed in review, and that of Lapworth (1879) accepted, with the additional families due to subsequent discoveries. As respects the phylogeny of the Graptoloidea, the views of Marr

and Nicholson (1895, as extended by Elles 1898) are adopted, and a comprehensive table is appended, illustrating the author's "Suggested Phylogeny of the American Graptolite Axonolipa."

In dealing with the geological range of the Graptolites Ruedemann summarises in brief the far-reaching results already arrived at on both sides of the Atlantic by previous graptolithologists, and combines them with the main results of his own researches in a general "Correlation Table" of the Upper Cambrian and Lower Ordovician formations of Scandinavia, Great Britain, Canada, and New York. In calling special attention to the long-accepted generalisation of the almost world-wide distribution of the same (or a large percentage of the same) characteristic genera and species in corresponding zones, he argues that while there appear to be some evidences of a local nature accordant more or less with the four theoretic Lower Palæozoic "provinces" of Frech and others (deduced from the geographical distribution of the Trilobita, Brachiopoda, etc.), yet there are other facts entirely at variance with the distribution of the land and water areas as they can be constructed for the Lower Siluric (Ordovician) age from the study of the littoral faunas. His remarks are illustrated by a world-chart.

As respects the mode of existence of the Graptolites, Ruedemann agrees with those who regard the majority of the genera of the Dendroidea as being permanently attached to rocks or growing sea-weeds in the littoral regions, thus forming a part of the marine *benthos* of their time; while the majority of the Graptoloidea were probably attached to sea-weeds alone, and shared their fate, whether remaining permanently moored to rocks or the sea-floor off-shore, or drifting (like the modern Sargassum) as *pseudo-plankton* far and wide over the surface of the deep seas. Some forms, however, and notably those arranged in stellate groups Rudemann considers, had possibly attained a holoplanktonic stage of existence corresponding with that of the Siphonophora of the present day.

In the Descriptive Section of the volume Ruedemann gives diagnoses of some forty species of Graptolites occurring in the New York formations dealt with. These are arranged by him in six families, viz. 1, Dendrograptidæ (Roemer); 2, Dichograptidæ (Lapw.); 3, Cœnograptidæ (nov.); 4, Phyllograptidæ (Lapw.); 5, Diplograptidæ (Lapw.); and 6, Climacograptidæ (Frech); and seventeen genera, of which two, **Sigmagraptus** and **Strophograptus,** are new. The following are the new species described: *Dendrograptus* (?) **succulentus,** *D.* **fluitans,** *Ptilograptus* **tenuissimus,** *Dictyonema* **farciferum,** *D.* **rectilineatum,** *Desmograptus* **intricatus,** *Goniograptus* **gometricus,** *G.* **perflexilis,** *Temnograptus* **Noveboracensis,** *Bryograptus* **Lapworthi,** *B.* **pusillus,** *Tetragraptus* **Clarkei,** *T.* **Woodi,** *T.* **taraxicum,** *T.* **pygmæus,** *T.* **lentus,** *Didymograptus* **cuspidatus,** *D.* **Ellesi,** *D.* **Tornquisti,** *D.* **spinosus,** *D.* **forcipiformis,** *D.* **incertus,** *Sigmagraptus* **præcursor,** *Strophograptus* **trichomanes,** *Diplograptus* **laxus,** *D.* **longicaudatus,** *Glossograptus* **hystrix,** *G.* **echinatus,** *Climacograptus* **spongens**

These are illustrated in seventeen excellent quarto plates, in which the majority of the forms are given in natural size and detail.

The letterpress of the work is enriched by 106 Text-figures, most of them on a common scale of five times the original size.

1905.
Flamande, B. M.,
"Existence de schistes à Graptolithes à Haci-El-Khenig (Sahara Central)," 'Comptes Rendus Acad. Sciences,' vol. cxl, pp. 954–957.

Note of the discovery of Graptolites of Silurian Age in the Sahara, by Captain Cottenest and Mons. M. Foureau, in 1902, with a description of the position and lithology of the containing rocks.

1905.
Gentil, L.,
"Sur la présence de schistes à Graptolithes dans le Haut-Atlas Marocain," 'Comptes Rendus Acad. Sciences,' vol. cxl, p. 1659.

A brief account of the author's discovery of Silurian (Llandovery) Graptolites in the strata of the High Atlas, Morocco, with lists of species present and notes upon the forms previously obtained from Silurian strata in the Sahara. (See also Munier Chalmas, "Notice sur les travaux scientifiques," Lille, 1903, p. 94, and "Documents de la Mission Saharienne," by MM. Foureau, Gentil and Haug, 1905, pp. 755–756.

1905.
Fearnsides, W. G.,
"The Geology of Arenig Fawr and Moel Llyfnant," 'Quart. Journ. Geol. Soc.,' vol. lxi, pp. 608–640.

A detailed description of the geological succession ranging from the base of the Upper Cambrian to the Middle Bala in the classic Arenig region. Some twenty-five species of Graptolites are named as present in the succession, and their relative horizons and ranges are carefully noted.

1905–6.
Lapworth, C.,
"On the Graptolites from Bratland, Gausdal, Norway," 'Norges Geol. Undersogelse,' no. 39.

A description of the species of Graptolites collected by Herr Bjorlekke, of the Geological Survey of Norway, in the Ordovician Shales of Bratland, Gudbrandsdal, in 1890. Ten distinct forms are noted, and illustrated on a plate. Two forms are given as new: *Dicellograptus* **laxatus** and *Didymograptus euodus* (Lapworth) var. **Bjorlekki.** A table is given (p. 5) showing the distribution of the Bratland forms in Norway, Sweden, Great Britain, and North America, and the containing strata are assigned to the higher Arenig rocks of the British Succession (Zones of *Didymograptus extensus* and *D. hirundo*).

1905.
Pirie, J. H.,
"Graptolite-bearing Rocks of the South Orkneys, 'Proc. Roy. Soc. Edinburgh,' vol. xxv, pp. 463–470.

A note of the discovery of the genus *Pleurograptus* in the sedimentary rocks of the South Orkney Islands, 800 miles south-east of Cape Horn.

1905.
Hall, T. S.,
"Victorian Graptolites," pt. 3, 'Proc. Roy. Soc. Victoria,' vol. xviii, pp. 20–24, pl. vi.

Identification of several species of Graptolites collected by Mr. Thiele from the Upper Ordovician Strata of Victoria. Two new species are figured—*Diplograptus* **Thielei** and *Dicranograptus* **hians.**

1905.
Törnquist, S. L.,
"Paleontologiska meddelanden," 'Geol. Fören. Förhandl.,' vol. 27, pp. 452–457.

A correction of the specific nomenclature of several Swedish forms.

1905.
Schepotieff, A.
"Ueber Stellung der Graptolithen im Zoologischen System," 'Neues Jahrbuch für Mineralogie,' 1905, vol. 2, pp. 79–98.

The author commences by pointing out (with references) how the majority of earlier investigators (1865—1895) were in accord in assigning the Graptolites to the Hydroidea, while the latest researchers (1895—1901) have been gradually led to infer that the Graptolites either (1) constitute a special class of Cœlenterata, having a very distant relationship to the Hydroidea, or (2) they cannot be compared with any of the accepted groups of recent animals, but must be regarded simply as Invertebrata of unknown systematic position.

The paper itself is devoted to a comparison of the many points of resemblance between the structure of the polypary in the Graptolites (especially the Monograptidæ) and that of the polypary in the remarkable recent marine organism *Rhabdopleura Normani*, Allman, some of which were indicated by Allman himself as early as 1872. At that time *Rhabdopleura* was assigned to the Polyzoa (Bryozoa); but the subsequent progress of zoological research has placed it in company with the equally remarkable recent genus, *Cephalodiscus*, in a special class, Pterobranchiata (Ray Lankester, 1884), of the subphylum, Adelochorda, some members of which also suggest affinities with the Echinodermata on the one hand and with the Chordata on the other.

Schepotieff's residence in Norway, from whose deeper sea-waters the majority of the known examples of *Rhabdopleura* have been dredged, gave him special advantages on the study of its organisation. He describes his results in detail, and compares them with those of his microscopic study of sections of Bohemian specimens of *Monograptus* preserved in limestone.

He describes the main element or stipe of *Rhabdopleura* as a creeping, longitudinal tube, attached throughout by its flattened dorsal surface to some foreign body. In reality this longitudinal tube is composed of the basal portions of a uniserial succession of dwelling chambers inhabited by the individual zooids of the colony. Each such chamber may be described as divisible into two regions directed approximately at right angles to each other—namely, a basal, or proximal region, forming a constituent part of the longitudinal tube; and a distal, lateral,

and free region, having a mouth at its outer extremity. Thus the stipe in *Rhabdopleura* presents an appearance similar to that in some forms of the Monograptidæ (especially *Rastrites*); the longitudinal tube in *Rhabdopleura* answering in form and relation to the common canal in *Rastrites*, and the free portions of the successive chambers to the so-called "isolate thecæ" in that genus. In *Rastrites*, however, while the successive thecæ intercommunicate freely by means of the common longitudinal canal, in *Rhabdopleura* they intercommunicate only in their earliest stages, and later on in life are completely shut off from each other.

Imbedded in the dorsal wall of the longitudinal tube in *Rhabdopleura*, there runs from end to end an intensely black filament or cord, denominated by Schepotieff as the *stolo* (a title which we here retain in this place for convenience of reference). This stolo is composed of four members, namely, (1) an exceedingly minute axial rod running continuously down its centre and surrounded by three concentric tubular structures, (2) an inner cell-string, (3) a middle branching cell-layer, and (4) an outer cover of intense blackness.

Schepotieff agrees emphatically with those of his predecessors who have pointed out the agreement in position and relation of this stolo in *Rhabdopleura* with the virgula in the Monograptidæ, and he fortifies his view by the results of his own microscopic studies and those of others into the structure of *Monograptus*. He also brings forward other points of similarity in structural detail between *Rhabdopleura* and *Monograptus*, etc., such as the common presence of minute growth-lines or transverse rings which meet at an angle on the ventral side of the thecæ, the presence of periodic projections on the solid axis, etc.

We are wholly unable to agree with Schepotieff's identification of the growing portion in *Rhabdopleura* with the sicula in *Monograptus*, but his paper (which is illustrated by several good Text-figures) should be read by all students of Graptolite literature.

1906.
Törnquist, S. L.,
"Sundry Geological and Palæontological Notes," 'Geol. Fören. Förhandl.,' vol. 28, pp. 497–515.

In a first of these notes the author expresses his agreement with the views of those who regard the *Dictyonema* and *Ceratopyge* beds of Sweden as constituting in combination the first member of the Scandinavian Ordovician. In a second he discusses at length the synonomy of the forms which have been referred to *Isograptus gibberulus* (Nich.), *Didymograptus patulus* (Hall), and *Didymograptus constrictus* (Hall).

1906.
Moberg, J. C., and Segerberg, C. O.,
"Bidrag till kanndomen om Ceratopygeregionen," 'Lund's Geol. Fältklubb.,' ser. *b*, no. 2, pp. 1–110, pls. i–vii.

A comprehensive essay on the *Dictyonema* and *Ceratopyge* beds of Sweden, regarded as constituting collectively a single formation. This is divided by the authors into two main sections, namely, a lower or *Dictyograptus* section, and an upper or *Ceratopyge* section, each of these sections being composed of a lower and an upper zone. All the fossil forms —Brachiopoda, Trilobites, and Graptolites—recognised by the authors as afforded by the formation, are figured and

described, and an admirable account is given of the history of previous research and opinion respecting the formation as a whole and its extra-Scanian equivalents. Some eight forms of Graptolites are recognised by the authors as characteristic of the formation. Of these the following are given as new: *Clonograptus tenellus* (Linnarsson) var. **hians** (Moberg), *Clonogr.* **heres** (Westergard), and *Bryograptus* **Hunnebergensis** (Moberg).

1906.
Wood, E. M. R.,
"Graptolites from Bolivia," 'Quart. Journ. Geol. Soc.,' vol. lxii, pp. 431, 432.

A brief note on the Graptolites collected by Dr. J. W. Evans during his expedition to Bolivia in 1901—1902. Seven species of Bolivian Graptolites are recognised; and on the evidence afforded by the collective assemblage the containing strata are paralleled with the Upper Arenig Formation of Britain.

1906.
Wood, E. M. R.,
"Tarannon Series of Tarannon," 'Quart. Journ. Geol. Soc.,' vol. lxii, pp. 644–701.

This comprehensive paper is devoted to the description and the discussion of the stratigraphy and palæontology of the Tarannon Formation as worked out in detail by the authoress in the typical area of central Wales. The great vertical extent of the formation is demonstrated and its conformable relations to the Llandovery Formation below and the Wenlock above. It is shown to consist of four recognisable sub-formations, marked by characteristic graptolitic sub-faunas. These are arranged in four zones, namely, those of (1) *Monograptus turriculatus*, (2) *Mono. crispus*, (3) *Mono. Griestonensis*, (4) *Mono. crenulatus*.

The immediately overlying Wenlock and underlying Llandovery local Graptolite zones are also worked out, and their containing species noted. Some thirty-eight forms of Graptolites are quoted from the Tarannon Series itself, of which seven are survivals from the Llandovery beds and five range upwards into the Wenlock Series.

The paper is illustrated by tables showing (i) the correlation of the local Tarannon sub-formations with their representatives elsewhere in Britain, Sweden, and Bohemia, and (ii) the geological and geographical distribution of the species of Graptolites identified in the typical Tarannon area. Upon one of these tables the Graptolites are arranged in the order of their chronological appearance.

1906.
Elles and Wood,
"Monograph of British Graptolites," pt. 2, Palæontographical Society, 1906.

In this Fifth Part of the British Monograph the Historical Section embraces the period 1871—1880. The Descriptive Section opens with an account of the structure and mode of development of the family of the Diplograptidæ (Lapworth) in general. The remainder of the Part is devoted to the diagnoses and illustration of the British forms belonging to the genus *Climacograptus*, Hall (which is assigned to that family) and its constituent forms arranged under five different types. Nineteen British species of *Climacograptus* are recognised, the following being described as new: *Climaco-*

graptus **Tornquisti,** *Cl.* **brevis,** *Cl.* **supernus,** and *C.* **latus,** together with several varieties.

1906.
Hall, T. S.,
"Reports on Graptolites," 'Records Geol. Surv. Victoria,' vol. i, pp. 266–278, pl. xxxiv.

Annotated lists of Graptolites identified by the author from many localities in Victoria, with figures and descriptions of three new species: *Climacograptus* **mensuris,** *C.* **Baragawanathi,** and *Diplograptus* **ingens.**

1906.
Evans, D. C.,
"Ordovician Rocks of Western Caermarthenshire," 'Quart. Journ. Geol. Soc.,' vol. lxii, pp. 597–643.

An excellent summary of the results of the author's field-researches in a most complicated district. The paper is illustrated by a geological map of the area described and tables of fossils, etc. The stratigraphical succession, which extends from Middle Arenig (*Didymograptus bifidus* zone) to the Lower Llandeilo (Llandovery) inclusive, is rich in Graptolites on several horizons. Fifty-four species are recognised by the author, and their localities and ranges given.

1907.
Fearnsides, W. G., Elles, G., and Smith, B.,
"The Lower Palæozoic Rocks of Pomeroy," 'Proc. Roy. Irish Acad.,' vol. xxvi, pp. 97–128.

A description of the results of a combined field-study of the strata and fossil contents of the Lower Palæozoic Rocks of Portlock's classic district of Pomeroy, North Ireland. Especial attention is paid to the zonal sequence of the included forms of Graptolites, of which thirty-four species and varieties are named from the Pomeroy formations, and their sequence and correlation given in an accompanying table.

1907.
Vinassa de Regny, P.,
"Graptoliti Carniche," 'Congresso dei Naturaliste Italiani,' 1906, pp. 1–27, pl. i.

The author gives a table of some twenty-five species and varieties of Graptolites collected from the Lower Palæozoic rocks on the Italian versant of the main range of the Carnic Alps, and assigns the containing beds in part to the Llandovery and in part to the Wenlock-Ludlow. The majority of the forms are referred to well-known British species, but three are noted as new: *Dendrograptus* (?) **carnicus,** *Desmograptus* **italicus,** *M.* **colonus,** (Barr.) var. **intermedius.** A brief bibliography introduces the work. A description of each species and an accompanying plate allows of the identification of most of the forms represented.

1907.
Moberg, J. C.,
"Skånes *Dicellograptus* Skiffer," etc, 'Geol. Fören. Förhandl.,' vol. 29, pp. 75–83, pl. i.

The author noted the discovery of *Pleurograptus linearis* (Carr.) in the *Dicellograptus* Beds of Scania, and discusses and tabulates in zonal form the whole of the Ordovician of Scania, parallels the Trilobite-facies and Graptolite-facies, and recognises under distinct names some fourteen Graptolite Zones in the general sequence.

Founding mainly upon collections made by himself in Sweden and Central Europe, supplemented by examples collected by Herr Eisel of Gera, Thuringia,

Törnquist revises, describes, and figures the chief recognisable forms of Monograptidæ assignable to the group *Rastrites* of Barrande. He discusses and accepts the generic or sub-generic value of the group, and in the main body of the paper deals with some thirteen species and varieties of *Rastrites*, among which the following are given as new: *R. peregrinus* (Barr.) var. **pecten** and var. **socialis,** *R. approximatus* (Perner) var. **Geinitzii.** The remainder of the paper is devoted to a critical description of those forms of *Monograptus* proper which are most closely allied to *Rastrites.* Of these one new form is given, *Monograptus* **amphibolus** (Törnquist).

1907. *Törnquist, S. L.,* "On the genus Rastrites and some allied species of *Monograptus*," 'Lund's Univ. Årsskrift,' vol. 3, pp. 1–22.

1907. *Elles and Wood,* "Monograph of British Graptolites,' pt. 2, Palæontographical Society, 1907.

The Historical Section of this Sixth Part embraces the period 1881—1895. The Descriptive Section deals with the forms collectively assigned to the genus *Diplograptus* proper. This section commences with an account of the general characteristics of the genus, the nomenclature employed, and the grouping adopted. The British species and varieties are arranged in four main groups. One of these receives a new name, **Mesograptus.** A minor group is also novel, viz., **Amplexograptus** (Lapw. MS.). Some twenty-five British species of *Diplograptus* are described. The new forms noted are *Diplograptus* **mutabilis,** *D.* **serratus,** *D.* **multidens,** *D.* **artus,** and *D.* **Pageanus** (Lapw. MS.).

1907. *Hind, W.* "On the Occurrence of Dendroid Graptolites in British Carboniferous Rocks," 'Proc. Yorks. Geol. Soc.,' vol. xvi, pp. 155–157, pl. xviii.

Dr. Hind describes and figures two forms of Graptolites discovered by Mr. Tate in the Pendleside Series of the British Carboniferous, viz. *Callograptus* **carboniferus,** and *Desmograptus* **Monensis.** These forms are of especial interest to geologists and palæontologists, as no Graptolites had previously been detected in British strata of more recent geological date than the Silurian.

1908. *Ruedemann, R.,* "Graptolites of New York. Pt. 2: Graptolites of the Higher Beds," 'New York State Museum, Memoir XI,' pp. 1–487, pls. i–xxxi.

This second volume, completing the author's Monograph of the Graptolites of New York State, sustains the high reputation of the first volume in respect both to matter and illustrations. It treats of the Graptolites which occur in the New York strata of later geological age than those of the Chazy Formation, commencing with those of the famous Ordovician "Norman's Kill Zone," and ending with those of the American Carboniferous. Like the first volume, it falls into two sections—a General Section, dealing with the literature and geological and geographical distribution of the genera and species concerned, their morphology and zoological relationships, etc.; and a Descriptive Section, in which the forms themselves are diagnosed and figured.

Full justice is done to the results arrived at by previous observers, and especial

attention is very properly called throughout to the memoirs and conclusions of Dr. Gurley on American Graptolites. Several of his MS. diagnoses, figures, and descriptions are included, and their sources acknowledged in the body of the work.

The General Section of the volume is illustrated by tables of local distribution, zonal range, and classification. The earlier and later nomenclatures of the Graptolite-bearing formations are given and discussed. Five successive Graptolite zones are distinguished in the Upper Ordovician, namely, those of (1) *Nemagraptus gracilis*, (2) *Diplograptus amplexicaulis*, (3) *Glossograptus quadrimucronatus*, (4) *Diplograptus peosta*, (5) *Dicellograptus complanatus*, embracing the American strata ranging from the base of the Black River Formation to the top of the New York Ordovician.

The notes on morphology, etc., given in the first volume are here supplemented and extended. The known facts and varied views respecting spines, basal discs, vesicles, virgula, nema, retiolite-structure, etc., are adduced and discussed, and illustrated by abundant text-figures, and several new observations respecting the polypary and thecæ in the Graptoloidea are brought forward. Attention ought also to be called to Ruedemann's notes, descriptions, and figures of the so-called genera which he classes together under the title of 'Genera incertæ sedis.' Of these, the most important constitute the group *Corynoides* of Nicholson, which Hopkinson and Lapworth (1875) erected into a distinct family under the title of Corynograptidæ. The author changes the name to Corynoidæ, and gives several instructive figures of the New York forms. These he identifies with the known British species, but recognises several varieties.

The Descriptive Section of the volume is devoted to the diagnoses and figures of the Graptolite forms themselves. One hundred and seventeen species are recognised by the author, of which fifty-one are assigned to the Dendroidea and sixty-six to the Graptoloidea. Three new genera, viz. **Ptiograptus** and **Mastiograptus**, are classed among the Dendroidea. The new species of Dendroidea include *Dendrograptus* **rectus**, *Ptiograptus* **Poctai**, *P.* **Hartnageli**, *Odontacalis* **hepaticus**, *Ptiograptus* **percorrugatus**, *Desmograptus* **tenuiramosus**, *D.* **cadens**, *D.* **Vandelooi**, *Cactograptus* **crassus**, *Palæodictyota* **anastomotica**, *P.* **Clintonensis**, *Mastigograptus* **circinalis**, together with the following MS. forms of Dr. Gurley: *Dictyonema* **polymorphum**, *D.* **Leroyense**, *D.* **Areyi**, *D.* **megadictyon**, *D.* **perradiatum.**

The new forms of Graptoloidea embrace *Azygograptus* **simplex**, *Syndograptus* **pecten**, *Dicellograptus* **mensurans**, *D.* **Smithi**, *C.* **Mississippiensis**, *C.* **modestus**, *Cyrtograptus* **Ulrichi**, and the following MS. species of Lapworth: *Azygograptus* **Walcotti**, *Nemagraptus* **exilis**, *Dicranograptus* **Gurleyi.**

This second volume of Ruedemann's Monograph is clearly the work of an enthusiast in the subject; but one who nowhere poses as an authority, or disguises either the defects in our knowledge or the inevitability of diverse interpretations.

He takes it for granted throughout that the reader wishes to know in brief the facts already discovered, and by whom; and the various inferences already drawn, and why. That the reader, like himself, may be in a position to arrive at his own unbiased conclusions, he supplies him with a wealth of illustration and detail that are certain to render the monograph of especial value, not only to the field-geologist, but also to the beginner in Graptolithology.

1908.
Moberg, J. C.,
"Nomenklaturen för våra Paleozoiska bildningar," 'Geol. Fören. Förhandl.,' vol. 30, pp. 343–351.

After giving a carefully written but brief review and discussion of the history of the successive past improvements in the nomenclature of the Swedish Lower Palæozoic Rocks, the author expresses his agreement with the plan advocated by De Lapparent in 1900, namely, the retention of Murchison's term Silurian for the whole of the Palæozoic Formations regarded collectively, and the employment of the names Cambrian (Sedgwick), Ordovician (Lapworth, 1879), and Gothlandien (De Lapparent, 1900) for its three component divisions and their respective faunas. This paper, which had already been published by the author in the 'Geological Magazine' for 1907 (December 5, vol. vi, pp. 273—279), is of especial importance from the historical point of view, as the nomenclature advocated in its pages became subsequently adopted in the Geological Guides and Memoirs issued in connection with the International Geological Congress held in Stockholm in 1910, and in the majority of those Swedish Graptolite memoirs and papers which have been published since that date.

1908.
(*Mrs. Shakespear*) *Wood, E. M. R.*,
"On some New Zealand Graptolites," 'Geol. Mag. [5] vol. v, pp. 145–148.

An identification and discussion of twenty-one forms of Graptolites collected by Mr. Isaacson from Slaty Creek, New Zealand, for the British Museum (Nat. Hist.). It is pointed out that all the species distinguished in the collection are either identical with, or closely allied to, previously named British and North American forms whose association and geological range are already fairly well established in the Northern Hemisphere. Two Graptolitic sub-zones, distinguishable by lithological and palæontological characters, are noted by the author as represented in the collection. A table is given, showing the distribution of these New Zealand species in America and Great Britain, and the conclusion is drawn that, as the association of species in this collection is practically the same as their association in the Northern Hemisphere, it may be anticipated that further work will result in proving that the zonal succession of Graptolites, well established in the Northern Hemisphere, prevails in New Zealand also.

1908.
Hall, T. S.,
"Reports on Graptolites," 'Records Geol. Surv. Victoria,' vol. ii, pp. 221–227.

Lists of Graptolites collected by the officers of the Geological Survey in several Victorian localities.

1908.
Elles and Wood,
"Monograph of British Graptolites," pt. 7, Palæontographical Society, 1908.

In this Part the Historical Section is devoted to the Literature of Graptolite Research during the period 1895—1901. In the Descriptive Section the British forms of Diplograptidæ assigned to the sub-genus, *Petalograptus*, and also those of the genera, *Cryptograptus* and *Trigonograptus*, are treated of. The family of the Glossograptidæ is next taken up, then the Retiolitidæ, and finally the Dimorphograptidæ.

A remarkable new form, *Petalograptus* (?) *phylloides* is provisionally assigned to the Diplograptidæ. Two previously named but undescribed sub-genera, **Hallograptus** (Carruthers, MS.) and **Neurograptus** (Lapworth) are classed with the Glossograptidæ, together with two new sub-genera, **Thysanograptus** and **Nymphograptus**, and **Plegmatograptus** is assigned to the Retiolitidæ. The new species described in this part include *Petalograptus* **altissimus**, *P.* (?) **phylloides**, *Glossograptus* **acanthus**, *Nymphograptus* **velatus**, and *Plegmatograptus* **nebula**.

1908.
Kiær, J.,
'Das Obersilur im Kristianiagebiete, Christiania,' pp. 1–595.

A brilliant monograph dealing with the author's researches into the lithological and palæontological sequence in the Silurian (Llandovery to Ludlow) of the classical Norwegian district extending from Skien to the head of Lake Mjosen.

The work is illustrated by maps, plates, sections, abundant text-figures, tables of zonal distribution, and a special chapter on correlation. Four successive formations are recognised, parallel broadly with the British Lower Llandovery, Upper Llandovery (inclusive of the Tarannon), Wenlock and Ludlow respectively, the whole being divided into nineteen zones. In the palæontological parts of the work, although the chief attention is naturally directed to the extraordinarily prolific Brachiopod, Trilobite, and Coral faunas, the Graptolites are by no means neglected, some twenty-six distinct species being recognised, and their geographical and geological ranges in the districts described carefully indicated.

1908.
Hall, T. S.,
"Graptolite Beds of Dalesford," 'Proc. Roy. Soc. Victoria,' vol. ii, pp. 271–284.

Lists of the Arenig Graptolites from some thirty-four different Victorian localities.

1908.
Hall, T. S.,
"Reports on Graptolites," 'Records Geol. Surv. Victoria,' vol. ii, pp. 137–143, pl. xv.

Lists of Graptolites collected from Victorian localities, with figures and descriptions of two new species, *Diplograptus* **tardus** and *Didymograptus* **latus.**

1909.
Westergård, A. H., "Studier ofver Dichograptus Skiffern in Skåne, etc.," 'Lund's Geol. Fältklubb.,' ser. B, no. 4, pp. 1–79, pls. i–v.

Under the collective title of Didymograptus Skiffer, Westergard includes the Lower and shalier division of Angelin's *Ceratopyge* Region in contradistinction to the more compact and calcareous Upper Division, embracing the *Shumardia* beds and *Ceratopyge* Kalk proper, the Upper Division being distinguished further by a fauna consisting mainly of Trilobites and Brachiopods, while the Lower Division under description is marked by the presence of Graptolites. The present paper summarises the main facts and conclusions respecting the strata of this Lower Division, regarded by Scandinavian geologists as the basal member of the Swedish Ordovician, and of the beds which are in immediate contact with the sub-formation above and below. The memoir is introduced by a full bibliography of the history of previous research, followed by a detailed account of the results of the author's personal field-studies of the succession in Scania, Westergötland, Östergötland, Öland, etc.

The author arranges the strata of the *Dictyograptus* Skiffer in three sub-zones, characterised respectively by: (1) *Dictyograptus flabelliformis* (Eichw.). (2) Idem *Forma typica*. (2) *Clonograptus tenellus* (Linnrs.). (3) *Dictyograptus flabelliformis* var. *Norvegica* (Kjerulf.).

All the known fossils, so far as they are represented in the Lund Museum, are described in the body of the paper, and figured in the accompanying plates.

Especial attention is devoted to the Graptolites present. Nine distinct species and varieties are recognised. Two of these are noted as new, *Dictyograptus flabelliformis* (Eichw.) var. **confertus** (Linn. MS.) and *Clonograptus tenellus* (Linn.) var. **grandis**. All the Graptolite forms noted are admirably figured in the plates, some from striking photographs by Professor Moberg, and others from drawings by Mauda Broman and the author.

As respects that large group of Graptolites generally united by palæontologists under the common generic title of *Dictyonema*, Hall, Westergard expresses his opinion that the group is separable into two distinct sections or genera: (1) a section typified by *Dictyonema flabelliforme* (Eichw.), and (2) a section typified by *Dictyonema cervicorne* (Holm.), etc. To the first of these sections he restricts the generic title, *Dictyograptus* (Hopkinson and Lapw.), and for the second he proposes a new generic title—**Dictyodendron**. *Dictyograptus* he assigns to the Graptoloidea and *Dictyodendron* to the Dendroidea.

1909.
Elles, G. L., "Ordovician and Silurian Rocks of Conway," 'Quart. Journ. Geol. Soc.,' vol. lxv, pp. 169–194.

A description of the detailed results of the authoress' study of the lithological and palæontological succession in the rocks of the Conway District, ranging from the Llandeilian to Middle Wenlockian. Particular attention is paid to the Graptolites, some fourteen separate zones being recognised and named, and paralleled with their equivalents elsewhere in Great Britain.

1909.
Jones, O. T.,
"The Hartfell-Valentian Succession around Plynlimon and Pont Erwyd," 'Quart. Journ. Geol. Soc.,' vol. lxv, pp. 463–537.

An admirably detailed description of the local members and distribution of the lithological and palæontological succession, as worked out by the author, in the Plynlymmon District, Central Wales, through strata ranging from Upper Bala to Middle Tarannon (zone of *Dicellograptus anceps* to zone of *Monograptus Griestoniensis*). The strata described are locally rich in Graptolites. More than 100 distinct forms are recognised as present by the author; their distribution in the several local formations, stages, and zones is tabulated, and paralleled with their known arrangement in equivalents elsewhere in Britain. Two new species of Graptolites, *Monograptus* **atavus** and *M.* **Rheidolensis,** are figured and described.

1908–9.
Moberg, J. C., and Törnquist, S. L.,
"Retioloidea Skånes Colonusskiffer," 'Sveriges Geol. Undersökning,' Årsbok 2, no. 5.

The authors record the occurrence of **Plectograptus macilentus** (Törnquist), *Retiolites spinosus* (Wood), *Gothograptus nassa* (Holm), in the Scanian-*Colonus* Shales. The structure of the first named, which is made the type of a new genus, is described and figured in detail. For the central rod-like body, or "filiform organ," figured by Holm in his *Gothograptus nassa*, and provisionally termed "Virgula" by Wiman—with the reservation, however, that it is not apparently morphologically identical with the virgula of the Diplograptidæ—the authors of this paper propose the neutral title of "fulcell" (Latin "fulcimen," a prop or stay).

1909.
Hall, T. S.,
"Notes on Graptolites from Tallong, New South Wales," 'Records Geol. Surv. N.S. Wales,' vol. viii, pp. 339–341, pl. lv.

A list of twelve forms of Graptolites collected by the officers of the New South Wales Geological Survey. The majority are identified with previously known species, but one variety (*Dicranograptus hians* (T. S. Hall) var. **apertus**) is noted as new.

1910.
Moberg, J. C.,
"Guide for the Principal Silurian Districts of Scania," 'Geol. Fören. Förhandl.,' vol. 32, pp. 45–194.

In this valuable memoir the author gives a minutely detailed description of the most important Cambrian, Ordovician, and Silurian fossiliferous localities in Scania including the famous Graptolite-bearing areas of Fögelsång, Jerrestad, Röstånga, Tösterup, etc., illustrating the work by many maps, tables of local zonal sequence, and by a bibliography ranging from 1827 to 1909 inclusive. The long extended, detailed, and successful researches of Prof. Moberg in the Lower Palæozoic rocks and fossils of Scania give an especial authority to this memoir, and it is certain long to remain the standard field guide to the region.

1910.
Elles and Wood.
"Monograph of British Graptolites," pt. 2, Palæontographical Society, 1910.

This Part of the Monograph is wholly Descriptive. It is introduced by a section dealing with the general characteristics of the family Monograptidæ and of the genus *Monograptus*, followed by diagnoses and illustrations of British species belonging to the first three of the seven component groups of Monograpti recognised by the authors. None of the species described are named as new, but several forms previously regarded as species by other authors are here classed as varieties.

1910.
Fricke, M.
"Die Silurischen Ablagerungen am Südrande des Zwickauer Kohlenbeckens," pp. 1–53. Zwickau, 1910.

A privately printed geological and palæontological memoir on the Silurian strata south of Zwickau, Saxony, with special reference to the Graptolite fauna. The work is somewhat popular in character, but apparently the result of several years' enthusiastic research. It is introduced by a discussion of the results obtained by previous researchers in the neighbouring regions of Thuringia, etc., and embraces a brief description, illustrated by many good text-figures, of the typical forms and structures of the Graptolites in general. A list of the local Graptolites of the region, including some eighty species and varieties, is carefully tabulated, the forms cited being grouped for eight different localities, and in the zones and sub-zones previously defined by Eisel, to whose long extended labours and successful results in the equivalent Graptolitic deposits of Thuringia appropriate references are made.

1910.
Törnquist, S. L.,
"*Cyrtograptus*-arter från Thüringen, etc.," 'Geol. Fören. Förhandl.,' vol. 32, pp. 1559–1575, pl. lxii.

The author describes and figures Thuringian examples of his species, *Cyrtograptus radians* (Törnquist) (see bd. 9, p. 491) and a remarkable new form, *Cyrtograptus* **multiramis.** He appends sundry historical and critical observations upon the detailed grouping of the Monograptidæ in general, and of several of the forms referred to by Jaekel (1899) and Frech (1897) in particular.

1910.
Lapworth, C.
"Graptolites," 'Encyclopædia Britannica,' 11th ed., vol. xii, pp. 365–367, figs. 1–28.

A brief summary of the existent state of knowledge and opinion respecting the Graptolites in general, their structure, development, classification, systematic position, and geological and geographical range. Two main sections—viz. Graptoloidea and Dendroidea—are recognised, united under the collective title of **Graptolithina.** The article is illustrated by figures of the adult polypary in several of the more characteristic genera, and of the sicula and the early parts of the polypary in the best known species.

1911.
Hadding, A.,
"Svenska Arterna af Släktet Pterograptus, Holm," 'Geol. Fören. Förhandl.,' vol. 33, pp. 487–494, pl. vii.

A welcome summary, discussion, and extension of previous knowledge and opinion respecting the geological distribution, range, and alliances of the genus *Pterograptus*, Holm, illustrated by clear and instructive figures.

1911.
Törnquist, S. L.,
"Graptolitologiska bidrag," III–VII, 'Geol. Fören. Förhandl.,' vol. 33, pp. 421–438, pls. v, vi.

Törnquist describes his discovery of *Lasiograptus* (*Hallograptus*) *mucronatus*, Hall (= var. *bimucronatus*, Nich.), in the Flag-kalk of the Siljan region, together with *Glyptograptus teretiusculus*, His., and discusses the geological horizon of the containing beds. He treats of the synonymy of two previously known forms in the upper *Didymograptus* Shales of Fögelsång, and classes them as *Didymograptus bifidus*, Hall, and *D.* **lentus,** Törnquist, sp. nov. He indicates the resemblance of *Cyrtograptus Ulrichi*, Ruedemann, to *C. multiramis*, Törnq., and describes and figures three forms from the *Phyllograptus densus* zone of Flagebro, viz. an example of the form *Chætoides*, Gurley, and two of *Clonograptus.* A specimen of *Dendrograptus* conf. *serpens*, Hopk., is also described by him from Bornholm.

1911.
Horn, E.,
"Eine Graptolithenkolonie aus Westergötland," 'Geol. Fören. Förhandl.,' vol. 33, pp. 237–239.

The author figures and describes a radiating assemblage of examples of *Climacograptus scalaris*, from the *Rastrites* beds of Westrogothia, of the type of one of Ruedemann's "synrhabdosomes."

1911.
Wade, A.,
"Llandovery and Associated Rocks of N.E. Montgomeryshire," 'Quart. Journ. Geol. Soc.,' vol. lxvii, pp. 415–459.

A summary of the results of the author's field work in the Welshpool district, the sequence described ranging from Llandeilo-Caradoc (Glenkilk-Hartfell) to Lower Ludlow inclusive. Twenty-eight Graptolite species are noted in the succession, and their stratigraphical and distributional arrangement described and discussed.

1911.
Watney, G. R., and Welch, E. G.,
"Zonal Classification of Salopian Rocks, Cautley and Ravenstonedale," 'Quart. Journ. Geol. Soc.,' vol. lxvii, pp. 215–237.

An account of the detailed local sequence in the Wenlock and Lower Ludlow beds of a large area in Westmoreland, especial attention being devoted to the Graptolites present. Six distinct Graptolite zones are distinguished and named. Thirty-four distinct forms are recognised, and their localities and ranges given and discussed.

1912.
Törnquist, S. L.,
"Graptolitologiska bidrag," VIII, IX, X, 'Geol. Fören. Förhandl.,' vol. 34, pp. 603–622, pl. viii.

In the first of these contributions Törnquist gives a minutely detailed critical review of the history of discovery and opinion respecting the species *Monograptus spiralis*, Geinitz, illustrating it by a plate, including not only Geinitz's original species, but also those of examples collected by Eisel from the actual locality whence Geinitz obtained his original specimen. In the second contribution Törnquist discusses the asserted synonomy of *Monograptus discus*, Törnq., and *M. veles*, Richter. In the third he makes known the presence of the British zonal forms, *Diplograptus acuminatus*, Nich., and *D. vesiculosus*, Nich., in the Lower *Rastrites* Shales of Röstånga.

1912.
Ruedemann, R.,
"Lower Siluric Shales of the Mohawk Valley,"
'New York State Museum Bull.,' clxii,
pp. 1–151.

In this paper the author gives a detailed description of the local succession, lithology, and fauna of the "Utica Slate" and associated sub-formations outcropping in the broad Shale Belt, extending from Albany north-westwards up the valley of the Upper Hudson River to Saratoga and Glenfalls, and westwards up the valley of the Mohawk to Littlefalls and Utica. The memoir, which is illustrated by several good plates and by local lists of the Graptolites, etc., collected *in situ*, goes far to satisfy a long-felt want in respect to the vexed question of the relations of the so-called Utica Slate in its typical localities to the neighbouring sub-formations, ranging from the Trenton on the one hand to the Loraine on the other.

Among the Graptolites cited in the four successive local groups recognised by the author, the following forms are given as new: *Dictyonema* **multiramosum,** *Dicranograptus Nicholsoni* (Hopkinson) var. **parvulus,** *Diplograptus* (*Mesograptus*) **Mohawkensis,** *D.* (*Amplexograptus*) **macer.**

The example of *D. Nicholsoni* figured and described (Fig. 17, p. 79) is especially interesting, each of its branches showing a virgula-like axis prolonged distally as a naked rod or fibre well beyond the theca-bearing parts of the branch.

1912.
Elles and Wood,
"Monograph of British Graptolites," pt. 2,
Palæontographical Society, 1912.

This Ninth Part of the British Monograph is wholly descriptive. Diagnoses and figures of some fifty-three British species of Monograptidæ are given, among which are many forms not previously recorded from British strata. Four species are noted as new, namely, *Monograptus* **remotus,** *M.* **undulates,** *M.* **Knockensis,** *M.* **delicatulus.**

1913.
Ulrich, E. O.,
"The Ordovician-Silurian Boundary,"
'Compte-Rendu Congrès Géologique International, Canada (Toronto),' 1913,
pp. 593–669.

A detailed discussion, mainly from the palæontological point of view, of the evidences relating to the probable local positions of the North American (United States and Canada) stratigraphical horizon answering to that usually accepted in Britain and Europe as marking the upper limits of the Bala and the lower limits of the Llandovery. The bearing of the Graptolite species upon the subject is carefully noted, and the discovery of typical Birkhill Graptolites in the United States (Arkansas) is for the first time made known.[1]

1913.
Hadding, A.,
"Undre Dicellograptuskiffern i Skåne, etc.,"
'Lund's Universitets Årskrift,' vol. 9, no. 15,
pp. 1–39, pls. iii, viii.

A well-illustrated memoir on the sequence and fossils of the Swedish Graptolite-bearing strata which follow at once upon the "*Didymograptus geminus* strata," and answer more or less to the British Llandeilo Flags and Upper Llandeilo. The series is divided by the author into four successive zones, namely, the zones of (1) *Glossograptus Hincksii*; (2) *Climacograptus putillus*; (3) *Nemagraptus gracilis*; and (4) a zone in which

[1] Compare also Ulrich's "Revision of the Paleozoic Systems," 'Bull. Geol. Soc. of America,' vol. xxii, 1911, pp. 481–680; and Ulrich and C. Schuchert, "Palæozoic Seas and Barriers in Eastern North America," 'New York State Museum Bull.,' 1902, lii, pp. 633–663.

Graptolites are wanting. Twenty-six forms of Graptolites are described, and well illustrated by figures drawn by the author. Of these forms twelve are given as new—*Azygograptus* **Mobergi,** *Glossograptus* **Scanicus,** *Cryptograptus* **lanceolatus,** *Thysanograptus* **spinatus,** *Diplograptus* **Törnquisti,** *D.* **notabilis,** *D.* **propinquus,** *Dicranograptus* **irregularis,** *Dicellograptus* **vagus,** *D.* **minimus,** *Nemagraptus* **subtilis,** and *Desmograptus* **Tullbergi.** Founding upon specimens of which parts are preserved in relief, the author discusses the probable form and structure of the polypary and thecæ in the genus *Glossograptus*.

1913.
La Touche, T. H. D.,
"Geology of the Northern Shan States, Burma," 'Mem. Geol. Surv. India,' vol. xxxix, pt. 2.

A description of the geology of a wide region of Northern Burma, surveyed by the author; with notes on the characteristic fossils and a correlation of the containing formations with their Asiatic, European, and American equivalents.

In this work there is made known for the first time the discovery of Graptolites in the Lower Palæozoic rocks of South-East Asia. A list of the forms collected by the author and Mr. J. Coggin Brown, and identified by Miss G. Elles, is given. All the forms named are referred to well-known British species. (See also Coggin Brown, 'Records of Geological Survey of India.')

1913.
Davies, A. M., and Pringle, J.,
"Deep Borings at Calvert, Buckinghamshire," 'Quart. Journ. Geol. Soc.,' vol. lxix, pp. 308–342.

Notable from the point of view of British Graptolitic literature as recording the earliest discovery of Graptolites (*Clonograptus*) of Tremadoc Age in deep borings in Central England.

1913.
Törnquist, S. L.,
"Några anmärkningar om indelningar inom Sveriges Kambro-silur," 'Geol. Fören. Förhandl.,' vol. 35, pp. 407–438.

In this paper Törnquist gives an historical and critical summary and review of the discoveries and opinions respecting the distribution of those species of Graptolites which are of zonal significance in the various recognised formations and sub-formations of the Lower Palæozoic strata of Sweden, Norway, Denmark and Bohemia, and Britain. References to the papers cited are given in footnotes, and the most recent zonal nomenclatures for the Swedish Graptolite-bearing strata are given at appropriate places in the text.

1913.
Elles and Wood,
'Monograph of British Graptolites," pt. 10, pp. 487–526, pls. l–lii, Palæontographical Society, 1913.

This Tenth Part of the British Monograph is composed of three divisions. The first division deals with those forms of the Monograptidæ which the authors arrange in their seventh group *Rastrites* (*auctorum*). Of these only one species is noted as new, *Monograptus* (*Rastrites*) **setiger.**

The second division is devoted to the genus *Cyrtograptus* (Carruthers).

The third division deals with the Zonal Range of all the forms of the British Graptoloidea definitely recognised by the authors in the Descriptive sections of the Monograph. These forms are named as amounting to 372 in number, and are grouped in the order of the consecutive families and genera described in the body of the work. Some thirty-six British Graptolite zones are recognised and named by the authors A first table (Table A, pp. 516–525) entitled "The Zonal Distribution of the British Graptoloidea," shows the presence, so far as known, of each species and variety in the several British zones recognised. A second table (Table B, p. 526) entitled "The Vertical Range of the Zones of British Graptoloidea," exhibits the approximate relative position of each of the Graptolite zones named in the ascending Succession of the British Lower Palæozoic formations and sub-formations generally.

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A MONOGRAPH

OF

BRITISH GRAPTOLITES.

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SYSTEMATIC INDEX.

	PAGE
HISTORICAL INTRODUCTION	i
INTRODUCTION	1
DESCRIPTION OF GENERA AND SPECIES	5
Family Dichograptidæ ...	5
Didymograptus	5
— Groups of	7
— extensus	8
— nitidus	10
— uniformis	12
— patulus	13
— hirundo	15
— sparsus	17
— pennatulus	18
— superstes	19
— euodus	21
— affinis	23
— gracilis	24
— acutidens	25
— Nicholsoni	27
— — var. planus	29
— serratulus	29
— simulans	30
— filiformis	32
— v.-fractus	33
— — var. volucer	35
— deflexus	35
— Murchisoni	37
— — var. geminus	40
— bifidus	42
— amplus	44
— indentus	45
— nanus	47
— artus	48
— stabilis	49
— fasciculatus	50
— gibberulus	52
Tetragraptus	55
Tetragraptus, Groups of	56
— quadribrachiatus	57
— crucifer	58
— Headi	59
— Amii	60
— fruticosus	61
— pendens	63
— Postlethwaitii	64
— serra	65
— reclinatus	67
— Bigsbyi	68
— Table of Species of	70
Schizograptus	70
— reticulatus	71
— tardifurcatus	72
Trochograptus	73
— diffusus	73
Holograptus	74
— Deani	75
Dichograptus	76
— Groups of ...	77
— octobrachiatus	77
— — var. Sedgwickii	79
— separatus	80
Loganograptus	80
— Logani	81
Clonograptus	82
— tenellus	83
— — var. Callavei	84
Temnograptus	85
— multiplex	86
Bryograptus	87
— Groups of	87
— Kjerulfi	88
— — var. cumbrensis	89
— divergens	90
Trichograptus	90
— fragilis	91

	PAGE
Azygograptus	92
— Groups of	93
— Lapworthi	93
— Hicksii	94
— suecicus	95
— cœlebs	97
— Table of Species of	98
Phyllograptus	98
— typus	99
— angustifolius	100
— anna	101
— ilicifolius var. grandis	102
Family Leptograptidæ	103
Leptograptus	104
— flaccidus	106
— — var. spinifer	108
— — var. macilentus	109
— — var. macer	110
— — var. arcuatus	111
— capillaris	112
— validus	113
— — var. incisus	114
— grandis	115
— latus	116
— ascendens	117
— Table of Species of	118
Pleurograptus	119
— linearis	119
— — var. simplex	121
Amphigraptus	121
— divergens	122
— — var. radiatus	123
— distans	124
Nemagraptus	125
— Groups of	126
— gracilis	127
— — var. surcularis	129
— — var. remotus	130
— — var. nitidulus	131
— explanatus	133
— — var. pertenuis	134
— Table of Species of	135
Family Dicranograptidæ	135
Dicellograptus	136
— Groups of	138
— complanatus	139
— — var. ornatus	140
— anceps	141

	PAGE
Dicellograptus divaricatus	143
— — var. rigidus	144
— — var. salopiensis	145
— intortus	146
— patulosus	147
— pumilus	149
— angulatus	149
— Forchammeri	150
— — var. flexuosus	152
— sextans	153
— — var. exilis	155
— Morrisi	155
— moffatensis	157
— elegans	159
— — var. rigens	161
— caduceus	161
— Table of Species of	162
Dicranograptus	164
— Groups of	165
— Clingani	165
— tardiusculus	167
— brevicaulis	168
— rectus	169
— celticus	170
— Nicholsoni	171
— cyathiformis	174
— ramosus	175
— — var. spinifer	176
— — var. longicaulis	177
— ziczac	177
— furcatus, var. minimus	179
— Table of Species of	180
Family Diplograptidæ	181
Climacograptus	182
— Groups of	183
— scalaris	184
— — var. normalis	186
— — var. miserabilis	186
— rectangularis	187
— medius	189
— Törnquisti	190
— minimus	191
— brevis	192
— bicornis	193
— — var. tridentatus	195
— — var. peltifer	196
— supernus	196
— Wilsoni	197

	PAGE
Climacograptus Wilsoni var. tubularis ...	199
— antiquus ...	199
— — var. bursifer ...	201
— — var. lineatus ...	201
— caudatus ...	202
— tubuliferus ...	203
— latus ...	204
— styloideus ...	205
— Scharenbergi ...	206
— Hughesi ...	208
— extremus ...	210
— minutus ...	211
— innotatus ...	212
— tuberculatus ...	213
— Table of Species of ...	215
Diplograptus ...	217
— Groups of ...	220
— Subgenus Orthograptus ...	222
— (Orthograptus) quadrimucronatus ...	223
— — — var. spinigerus ...	225
— — Pageanus ...	225
— — — var. micracanthus ...	226
— — — var. abnormispinosus ...	226
— — Whitfieldi ...	227
— — insectiformis ...	228
— — vesiculosus ...	229
— — — var. penna ...	231
— — bellulus ...	231
— — mutabilis ...	232
— — truncatus ...	233
— — — var. abbreviatus ...	235
— — — var. intermedius ...	236
— — — var. pauperatus ...	237
— — — var. socialis ...	237
— — cyperoides ...	238
— — calcaratus ...	239
— — — var. vulgatus ...	241
— — — var. acutus ...	242
— — — var. basilicus ...	243
— — — var. tenuicornis ...	243
— — — var. priscus ...	244
— — rugosus, var. apiculatus ...	245
— Subgenus Glyptograptus ...	247
— (Glyptograptus) tamariscus ...	247
— — — var. incertus ...	249
— — serratus ...	249
— — — var. barbatus ...	250
— — teretiusculus ...	250

	PAGE
Diplograptus (Glyptograptus) teretiusculus	
var. euglyptus ...	252
— — — var. siccatus ...	253
— — dentatus ...	253
— — — var. appendiculatus ...	255
— — sinuatus ...	255
— — persculptus ...	257
— Subgenus Mesograptus ...	258
— (Mesograptus) foliaceus ...	259
— — multidens ...	261
— — — var. compactus ...	262
— — modestus ...	263
— — — var. parvulus ...	264
— — — var. diminutus ...	265
— — magnus ...	266
— Subgenus Amplexograptus ...	267
— (Amplexograptus) perexcavatus ...	267
— — confertus ...	269
— — cœlatus ...	270
— — arctus ...	271
Petalograptus ...	273
— palmeus ...	274
— — var. latus ...	275
— — var. tenuis ...	276
— — var. ovato-elongatus ...	277
— ovatus ...	278
— minor ...	279
— altissimus ...	281
— folium ...	282
— (?) phylloides ...	284
Cephalograptus ...	285
— cometa ...	285
— tubulariformis ...	287
— (?) acuminatus ...	289
Orthograptus, Table of Species of ...	290
Glyptograptus " " ...	292
Mesograptus " " ...	293
Petalograptus " " ...	294
Cryptograptus ...	295
— tricornis ...	296
— — var. Schäferi ...	299
— Hopkinsoni ...	299
— (?) antennarius ...	300
Trigonograptus ...	301
— ensiformis ...	302
— — var. lanceolatus ...	303
Glossograptidæ ...	304
Glossograptus ...	307

	PAGE
Glossograptus *cf.* ciliatus	309
— Hincksii	309
— — var. fimbriatus	312
— armatus	312
— acanthus	314
— Table of Species of	315
Retiograptus	315
— Geinitzianus	316
— aculeatus	317
Lasiograptus	318
— Subgenus Hallograptus	320
— (Hallograptus) mucronatus	321
— — — var. inutilis	322
— — — var. bimucronatus	323
— — — var. nobilis	324
— Subgenus Thysanograptus	325
— (Thysanograptus) Harknessi	325
— — — var. costatus	327
— — — retusus	328
— Subgenus Nymphograptus	329
— (Nymphograptus) velatus	329
— Subgenus Neurograptus	331
— (Neurograptus) fibratus	331
— — margaritatus	332
Retiolitidæ	333
— Groups of	335
Retiolites, Subgenus Gladiograptus	336
— (Gladiograptus) Geinitzianus	336
— — — var. angustidens	338
— — perlatus	338
— — — var. Daironi	340
— Subgenus Plegmatograptus	340
— (Plegmatograptus) nebula	340
— — obesus	342
— — — var. macilentus	343
— Subgenus Gothograptus	343
— (Gothograptus) nassa	343
— — spinosus	345
— Table of Species of	346
Dimorphograptidæ	347
Dimorphograptus	348
— Groups of	348
— confertus	349
— — var. Swanstoni	350
— decussatus	352
— — var. partiliter	353
— physophora	353
— *cf.* longissimus	354
Glossograptus erectus	355
— elongatus	357
— extenuatus	358
Monograptidæ	359
Monograptus	359
— Groups of	361
— cyphus	362
— acinaces	364
— gregarius	365
— bohemicus	367
— concinnus	368
— Nilssoni	369
— leptotheca	371
— regularis	372
— jaculum	373
— variabilis	374
— nudus	375
— dubius	376
— vulgaris	378
— — var. curtus	379
— tumescens	379
— — var. minor	381
— comis	381
— *cf.* gotlandicus	382
— — ultimus	383
— revolutus	384
— — var. austerus	385
— — var. præcursor	386
— difformis	387
— argenteus	388
— — var. cygneus	389
— limatulus	390
— colonus	391
— — var. compactus	393
— — var. ludensis	394
— varians	395
— — var. pumilus	396
— Roemeri	397
— chimæra	398
— — var. Salweyi	400
— — var. semispinosus	401
— leintwardinensis	401
— — var. incipiens	402
— atavus	403
— Sandersoni	404
— incommodus	406
— tenuis	407
— argutus	408

	PAGE
Monograptus vomerinus	409
— — var. gracilis	411
— — var. crenulatus	412
— griestoniensis	413
— crenularis	414
— galaensis	415
— priodon	418
— pandus	421
— Marri	422
— cultellus	423
— riccartonensis	424
— Flemingii	425
— — var. primus	426
— — var. compactus	427
— uncinatus var. orbatus	427
— — var. micropoma	428
— irfonensis	429
— flexilis	430
— acus	431
— undulatus	432
— distans	433
— scanicus	433
— crinitus	435
— Jaekeli	435
— gemmatus	436
— turriculatus	438
— discus	439
— tortilis	440
— Sedgwickii	441
— Halli	443
— M'Coyi	446
— testis var. inornatus	446
— lobiferus	448
— runcinatus	450
— — var. pertinax	451
— Becki	452
— exiguus	453
— nodifer	454
— crispus	456
— flagellaris	457
— capillaceus	458
— retroflexus	459
— dextrorsus	460
— remotus	461
— Barrandei	462

	PAGE
Monograptus knockensis	462
— Clingani	463
— millepeda	465
— convolutus	467
— decipiens	469
— urceolus	470
— triangulatus	471
— — var. major	472
— raitzhainiensis	473
— denticulatus	474
— spiralis	475
— proteus	477
— delicatulus	478
— involutus	478
— circularis	479
— communis	480
— — var. rostratus	481
— fimbriatus	482
— — var. similis	483
— planus	484
— intermedius	485
— *cf.* elongatus	486
— (Rastrites) peregrinus	488
— — longispinus	489
— — setiger	490
— hybridus	491
— — approximatus var. Geinitzi	492
— — fugax	493
— — Linnæi	493
— — maximus	494
— Table of Species of	496
— (Rastrites) equidistans	500
— Table of Species of (*continued*)	502
Cyrtograptus	504
— Murchisoni	505
— Lundgreni	507
— rigidus	508
— symmetricus	509
— hamatus	510
— Linnarssoni	511
— Grayi	512
— Carruthersi	512
— Table of Species of	513
ZONAL RANGE OF BRITISH GRAPTOLOIDEA	514
VERTICAL RANGE OF ZONES	526

LIST OF ILLUSTRATIONS IN THE TEXT.

FIG.		PAGE
—	Parkes-Lapworth Microscope...	3
1.	Didymograptus bifidus	6
2.	— —	6
3.	Divergence of the stipes of Didymograpti	7
4.	Didymograptus extensus	9
5.	— nitidus	10
6.	— uniformis	12
7.	— *cf.* uniformis	13
8.	— patulus	14
9.	— hirundo	16
10.	— sparsus	17
11.	— superstes	20
12.	— euodus	22
13.	— affinis	23
14.	— gracilis	25
15.	— acutidens	25
16.	— Nicholsoni	27
17.	— — var. planus	29
18.	— serratulus	30
19.	— simulans	31
20.	— *cf.* filiformis	32
21.	— v.-fractus	34
22.	— — var. volucer	35
23.	— deflexus	36
24.	— Murchisoni	38
25.	— — var. geminus	41
26.	— bifidus	42
27.	— amplus	44
28.	— *cf.* indentus	46
29.	— nanus	47
30.	— artus	48
31.	— stabilis	49
32.	— fasciculatus	51
33.	— gibberulus	53
34.	Tetragraptus quadribrachiatus	57
35.	— Headi	59
36.	— Amii	61
37.	Tetragraptus fruticosus	62
38.	— pendens	63
39.	— Postlethwaitii	64
40.	— serra	66
41.	— reclinatus	67
42.	— Bigsbyi	69
43.	Trochograptus diffusus	74
44.	Dichograptus octobrachiatus var. Sedgwickii	79
45.	— separatus	80
46.	Clonograptus tenellus	84
47.	— Callavei	84
48.	Temnograptus multiplex	86
49.	Bryograptus Kjerulfi	87
50.	— —	88
51.	— — var. cumbrensis	89
52.	— divergens	90
53.	Trichograptus fragilis	91
54.	Azygograptus Lapworthi	93
55.	— Hicksii	94
56.	— suecicus	96
57.	— cœlebs	97
58.	Phyllograptus typus	99
59.	— angustifolius	101
60.	— anna	101
61.	Leptograptus *cf.* flaccidus	105
62.	— flaccidus	106
63.	— — var. spinifer	109
64.	— — — macilentus	110
65.	— — — macer	111
66.	— — — arcuatus	112
67.	— capillaris	112
68.	— validus	113
69.	— — var. incisus	114
70.	Leptograptus grandis	115
71.	— latus	116
72.	Pleurograptus linearis var. simplex	121
73.	Amphigraptus divergens	122

FIG.		PAGE
74.	Amphigraptus divergens var. radiatus	123
75.	— distans	124
76.	Nemagraptus gracilis	127
77.	— — var. surcularis	129
78.	— — — remotus	131
79.	— — — nitidulus	131
80.	— sp.	132
81.	— explanatus...	133
82.	— — var. pertenuis	134
83.	Dicellograptus sp.	135
84.	— complanatus	139
85.	— — var. ornatus	141
86.	— anceps	142
87.	— *cfr.* divaricatus	143
88.	— divaricatus var. rigidus	145
89.	— — — salopiensis...	145
90.	— intortus	146
91.	— patulosus	148
92.	— pumilus	149
93.	— angulatus	150
94.	— Forchammeri	151
95.	— — var. flexuosus	152
96.	— sextans	154
97.	— — var. exilis	155
98.	Morrisi	156
99.	Moffatensis	157
100.	— elegans	160
101.	— — var. rigens	161
102.	— caduceus	161
103.	Dicranograptus Clingani	166
104.	— tardiusculus	167
105.	— brevicaulis	168
106.	— rectus	170
107.	— celticus	171
108.	— Nicholsoni	172
109.	— —	173
110.	— cyathiformis	174
111.	— ramosus	175
112.	— — var. spinifer	176
113.	— ziczac	178
114.	— furcatus var. minimus	179
115.	— —	179
116.	Climacograptus Scharenbergi ...	182
117.	— Wilsoni	183
118.	— scalaris	184
119.	— — var. normalis	186
120.	— — var. miserabilis	187
121.	— rectangularis	188
122.	Climacograptus medius	189
123.	— Törnquisti	191
124.	— minimus	192
125.	— brevis	193
126.	— bicornis	194
127.	— supernus	197
128.	— Wilsoni	198
129.	— — var. tubularis	199
130.	— antiquus	200
131.	— — var. bursifer	201
132.	— — — lineatus	201
133.	— caudatus	202
134.	— tubiliferus	203
135.	— latus	205
138.	— styloideus	206
139.	— Scharenbergi	207
140.	— Hughesi	209
141.	— extremus	210
142.	— minutus	211
143.	— innotatus	212
144.	— tuberculatus	213
145.	Orthograptus quadrimucronatus ...	223
146.	— — var. spinigerus	225
147.	— Pageanus	225
148.	— — var. micracanthus	226
149.	— Whitfieldi	227
150.	— insectiformis	228
151.	— vesiculosus	229
152.	— bellulus	232
153.	— mutabilis	233
154.	— truncatus	234
155.	— — var. abbreviatus	235
156.	— — — intermedius	236
157.	— — — socialis	237
158.	— cyperoides	238
159.	— calcaratus	240
160.	— — var. vulgatus	241
161.	— — — acutus	242
162.	— — — basilicus	243
163.	— — — tenuicornis	243
164.	— — — priscus	244
165.	Diplograptus (Orthograptus) priscus	245
166.	Orthograptus rugosus var. apiculatus	246
167.	Glyptograptus tamariscus	248
168.	— — var. incertus	249
169.	— serratus	250
170.	— — var. barbatus	250
171.	— teretiusculus	250

FIG.		PAGE	FIG.		PAGE
172.	Glyptograptus teretiusculus var. euglyphus	252	219.	Neurograptus margaritatus	333
173.	— — — siccatus	253	220.	Gladiograptus Geinitzianus	337
174.	— dentatus	254	221.	— perlatus	339
175.	— sinuatus	256	222.	Plegmatograptus nebula	341
176.	— persculptus	257	223.	— obesus	342
177.	Mesograptus foliaceus	259	224.	— — var. macilentus	343
178.	— multidens	261	225.	Gothograptus nassa	344
179.	— — var. compactus	262	226.	Retiolites (Gothograptus) spinosus	345
180.	— modestus	263	227.	Dimorphograptus confertus	350
181.	— — var. parvulus	265	228.	— — var. Swanstoni	351
182.	— — — diminutus	265	229.	— decussatus	352
183.	— magnus	266	230.	— — var. partiliter	353
184.	Amplexograptus perexcavatus	268	231.	— physophora	354
185.	— confertus	269	232.	— *cfr.* longissimus	355
186.	— cœlatus	270	233.	— erectus	356
187.	— arctus	271	234.	— elongatus	357
188.	Petalograptus palmeus	274	235.	— extenuatus	358
189.	— — var. latus	276	236.	Monograptus cyphus	363
190.	— — — tenuis	277	237.	— acinaces	364
191.	— — — ovato-elongatus	278	238.	— gregarius	366
192.	— ovatus	279	239.	— bohemicus	368
193.	— minor	280	240.	— concinnus	369
194.	— altissimus	281	241.	— Nilssoni	370
195.	— folium	283	242.	— leptotheca	372
196.	— (?) phylloides	284	243.	— regularis	373
197.	Cephalograptus cometa	286	244.	— jaculum	374
198.	— tubulariformis	288	245.	— variabilis	375
199.	— (?) acuminatus	289	246.	— nudus	376
200.	Cryptograptus tricornis	297	247.	— dubius	377
201.	— — var. Schäferi	299	248.	— vulgaris	378
202.	Trigonograptus ensiformis	302	249.	— tumescens	380
203.	— — var. lanceolatus	303	250.	— — var. minor	381
204.	Glossograptus *cfr.* ciliatus	309	251.	— comis	381
205.	— Hincksii	310	252.	— *cf.* gotlandicus	382
206.	— — var. fimbriatus	312	253.	— ultimus	383
207.	— armatus	313	254.	— revolutus	385
208.	— acanthus	314	255.	— — var. præcursor	386
209.	Retiograptus Geinitzianus	316	256.	— difformis	387
210.	Hallograptus mucronatus	321	257.	— argenteus	388
211.	— — var. inutilis	322	258.	— — var. cygneus	389
212.	— bimucronatus	323	259.	— limatulus	390
213.	— — var. nobilis	324	260.	— colonus	392
214.	Thysanograptus Harknessi	326	261.	— — var. compactus	393
215.	— — var. costatus	327	262.	— — ludensis	394
216.	— retusus	328	263.	— varians	395
217.	Nymphograptus velatus	330	264.	— — var. pumilus	396
218.	Neurograptus fibratus	332	265.	— Roemeri	398
			266.	— chimæra	399

FIG.		PAGE
267.	Monograptus chimæra var. Salweyi	400
268.	— leintwardinensis	401
269.	— — var. incipiens	402
270.	— atavus	404
71.	— Sandersoni	405
272.	— incommodus	406
273.	— tenuis	407
274.	— argutus	408
275.	— vomerinus	410
276.	— — var. basilicus	411
277.	— — — gracilis	412
278.	— — — crenulatus	412
279.	— griestoniensis	413
280.	— *cf.* —	414
281.	— crenularis	414
282.	— priodon	419
283.	— pandus	421
284.	— Marri	422
285.	— cultellus	423
286.	— riccartonensis	424
287.	— Flemingii	426
288.	— — var. primus	426
289.	— — — compactus	427
290.	— uncinatus var. orbatus	428
291.	— — — micropoma	429
292.	— irfonensis	429
293.	— flexilis	430
294.	— acus	431
295.	— undulatus	432
296.	— distans	433
297.	— scanicus	434
298.	— crinitus	435
299.	— Jaekeli	436
300.	— gemmatus	437
301.	— turriculatus	438
302.	— discus	439
303.	— tortilis	441
304.	— Sedgwickii	442
305.	— Halli	444
306.	— M'Coyi	446
307.	— testis var. inornatus	447
308.	— lobiferus	449
309.	— runcinatus	450
310.	— — var. pertinax	452
311.	— Becki	452
312.	— exiguus	453
313.	— nodifer	454
314.	Monograptus crispus	456
315.	— flagellaris	457
316.	— capillaceus	458
317.	— retroflexus	459
318.	— dextrorsus	460
319.	— remotus	461
320.	— Barrandei	462
321.	— knockensis	463
322.	— Clingani	464
323.	— millepeda	465
324.	— convolutus	468
325.	— decipiens	469
326.	— urceolus	470
327.	— triangulatus	471
328.	— — var. major	472
329	— raitzhainiensis	473
330.	— denticulatus	474
331.	— spiralis	475
332.	— proteus	477
333.	— delicatulus	478
334.	— involutus	479
335.	— circularis	480
336.	— communis	481
337.	— — var. rostratus	482
338.	— fimbriatus	482
339.	— — var. similis	483
340.	— planus	484
341.	— intermedius	485
342.	— *cf.* elongatus	486
343.	— (Rastrites) peregrinus	488
344.	— — longispinus	489
345.	— — setiger	490
346.	— — hybridus	491
347.	— — approximatus var. Geinitzi	492
348.	— — fugax	493
349.	— — Linnæi	494
350.	— — maximus	495
351.	Cyrtograptus Murchisoni	505
352.	— —	506
353.	— Lundgreni	506
354.	— rigidus	509
355.	— symmetricus	509
356.	— hamatus	510
357.	— Linnarssoni	511
358.	— Grayi	512
359.	— Carruthersi	513

A MONOGRAPH

OF

BRITISH GRAPTOLITES.

BY

GERTRUDE L. ELLES, Sc.D.,

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AND

ETHEL M. R. WOOD, D.Sc.

[Mrs. SHAKESPEAR],

OF NEWNHAM COLLEGE, CAMBRIDGE; AND THE UNIVERSITY OF BIRMINGHAM.

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HISTORICAL INTRODUCTION.

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PLATES.

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INDEX.

NOTE.—After the semicolon the Roman numeral indicates the plate on which the species is figured, and the following Arabic numeral refers to the figure. Specific names to which no plate-number is given are regarded in the Monograph as synonyms. Casual references are in italics.

Amphigraptus 121
— distans ... 124; XVIII, 3
— divergens ... 122; XVIII, 1
— — var. radiatus 123; XVIII, 2
— radiatus 123
Amplexograptus 221, 267, 293
— arctus *221*, 271; XXXI, 16
— cœlatus *221*, 270; XXXI, 17
— confertus *221*, 269; XXXI, 18
— perexcavatus *221*, 267; XXXI, 15
Angle of divergence 6
Aperture 6
Azygograptus 92
— cœlebs ... ... 97; XIII, 4
— Hicksii ... ... 94; XIII, 2
— Lapworthi ... ... 93; XIII, 1
— suecicus ... ... 95; XIII, 3

Branching, lateral and dichotomous ... 70
Bryograptus 87
— Callavei 84
— divergens ... ... 90; XII, 2
— Kjerulfi ... ... 88; XII, 3
— — var. cumbrensis 89; XII, 4
— ramosus 88, 89

Cephalograptus *222*, 285, 294
— acuminatus *222*, 289; XXXII, 11
— cometa *222*, 285; XXXII, 10
— folium 282
Cephalograptus ovato-elongatus 277
— petalum *222*, 287
— tubulariformis 287; XXXII, 9
Cladograpsus capillaris 112
— Forchammeri 150
— gracilis 127
— linearis 119
Clathrograptus 315
— cuneiformis 316
Climacograptus 164, 182
— antennarius 300
— antiquus ... 199; XXVII, 4
— — var. lineatus 201; XXVII, 5
— — var. bursifer 201; XXVII, 6
— bicornis ... 193; XXVI, 8
— — var. longispina ... 193
— — var. tridentatus 195; XXVI, 9
— — var. peltifer 196; XXVI, 10
— brevis ... 192; XXVII, 2
— caudatus ... 202; XXVII, 7
— cœlatus *199*, 270; XXXI, 17
— confertus 269
— extremus ... 210; XXVII, 13
— Hughesii ... 208; XXVII, 11
— innotatus ... 212; XXVII, 10
— internexus 208
— latus ... 204; XXVII, 3
— medius ... 189; XXVI, 4

Climacograptus minimus ... 191; XXVII, 1
— minutus ... 211; XXVII, 12
— parvulus 264
— perexcavatus 267
— ramosus 175
— rectangularis 187, 190; XXVI, 5
— scalaris 184, 189; XXVI, 1
— — var. caudatus ... 202
— — var. miserabilis 186; XXVI, 3
— — var. normalis 186; XXVI, 2
— — var. rectangularis 187, 190
— — var. tubuliferus ... 203
— Scharenbergi 206; XXVII, 14
— styloideus ... 205; XXVII, 9
— supernus ... 196; XXVI, 11
— teretiusculus 189
— Törnquisti ... 190; XXVI, 6
— tuberculatus 213; XXVI, 7
— tubuliferus ... 203; XXVII, 8
— typicalis 271
— undulatus 208
— Wilsoni ... 197; XXVI, 12
— — var. tubularis 199; XXVI, 13
Clonograptus 82
— tenellus ... ... 83; XI, 2
— — var. Callavei ... 84; XI, 3
Cœnograptus 125
— explanatus 133
— gracilis 127
— nitidulus 131
— pertenuis 134
— surcularis 129
Coign 6
Common canal 6, 7
Crossing canal 6, 7
Cryptograptus 295
— antennarius ... 300; XXXII, 14
— Hopkinsoni ... 299; XXXII, 15
— tricornis ... 296; XXXII, 12
— — var. Schäferi 299; XXXII, 13
Cyrtograptus 504, 513
— Carruthersi ... ... 512; LII, 4
— Grayi ... ... 512; LII, 5
— hamatus ... ... 510; LII, 3
Cyrtograptus Linnarssoni ... ... 511; LI, 4
— Lundgreni ... ... 507; LII, 1
— Murchisoni ... ... 505; LI, 3
— rigidus ... ... 508; LII, 2
— symmetricus ... ... 509; LI, 5

Demirastrites urceolus 470
Dendrograpsus linearis 119
Denticle 6
Dicellograptus 136
— affinis 146
— anceps ... ... 141; XX, 3
— angulatus ... 149; XXI, 4
— caduceus ... 161; XXIII, 4
— complanatus ... ... 139; XX, 1
— — var. ornatus 140; XX, 2
— divaricatus ... ... 143; XX, 5
— — var. rigidus 144; XX, 6
— — var. salopiensis 145; XX, 7
— elegans ... 159; XXIII, 2
— — var. rigens 161; XXIII, 3
— Forchammeri 150; XXII, 1
— — var. flexuosus 152; XXII, 2
— intortus ... ... 146; XX, 4
— moffatensis ... 143, 157; XXIII, 1
— — var. divaricatus ... 144
— Morrisi ... 155; XXI, 6
— patulosus ... 147; XXI, 5
— pumilus ... 149; XXI, 3
— sextans ... 153; XXI, 1
— — var. exilis 155; XXI, 2
Dichograptidæ 5
Dichograptus 76
— aranea 77
— fragilis 91
— Logani 81
— multiplex 86
— octobrachiatus 77; IX, X, 1
— — var. Sedgwicki 79; X, 3
— reticulatus 71
— Sedgwicki 79
— separatus ... ... 80; X, 4
— tenellus 83
Dichotomous branching 70

Dicranograptidæ 135
Dicranograptus 164
— brevicaulis ... 168; XXIV, 3
— celticus ... 170; XXIV, 5
— Clingani ... 165; XXIV, 1
— cyathiformis 174; XXV, 2
— formosus 154, 168
furcatus 179
— — var. minimus 179; XXV, 4
— Nicholsoni ... 171; XXV, 1
— ramosus ... 175; XXIV, 6
— — var. longicaulis 177; XXIV, 7
— — var. spinifer 176; XXIV, 8
— rectus ... 169; XXIV, 4
— sextans 153
— spinifer 176
— tardiusculus... 167; XXIV, 2
— ziczac ... 177; XXV, 3
— — var. minimus ... 179
Didymograptus 5
— acutidens ... ... 25; II, 3
— affinis ... ...23, *25*; II, 1
— amplus ... ... 44; IV, 3
— anceps 141
— artus ... ... 48; IV, 6
— bifidus ... ... *6*, 42; IV, 1
— bryonoides 65
— caduceus *52*, *65*
— deflexus ... ... 35; II, 12
— divaricatus 143
— elegans 155, 159
— extensus ... ... 8; I, 1
— euodus ... ... 21; I, 10
— fasciculatus ... 50; II, 8
— filiformis 32
— flaccidus 106, 155
— Forchammeri 150
— fruticosus 62
— furcillatus 40
— geminus 45, 47
— gibberulus ... ... 52; II, 9
— gracilis ... ... 24; II, 2
— Headi 59
— hirundo ... ... 15; I, 5
— indentus ... 45, *49*; IV, 4
— indentus var. nanus ... 47
Didymograptus moffatensis 157
— Murchisoni... ... 37; III, 1
— — var. geminus 40; III, 2
— nanus ... ... 47; IV, 5
— Nicholsoni ... ... 27; II, 4
— — var. planus 29; II, 5
— nitidus ... ... 10, *30*; I, 2
— patulus ... ... 13, *15*; I, 8
— pennatulus... ... 18; I, 7
— quadribrachiatus 57
— serratulus ... *27*, 29; II, 7
— sextans 153
— simulans ... ... 30; II, 6
— sparsus ... ... 17; I, 6
— stabilis ... ... 49; IV, 2
— superstes ... ... 19; I, 9
— uniformis ... ... 12; I, 3, 4
— v-fractus ... ... 33; II, 10
— — var. volucer 35; II, 11
Dimorphograptidæ 347
Dimorphograptus 348
— confertus 349; XXXV, 3
— — var. Swanstoni 350; XXXV, 4
— decussatus 352; XXXV, 5
— — var. partiliter 353; XXXV, 6
— elongatus... 357; XXXV, 11
— erectus ... 355; XXXV, 9
— longissimus 354; XXXV, 8
— extenuatus 358; XXXV, 10
— physophora 353; XXXV, 7
— Swanstoni 350
— — var. Kurcki... 349
Diplograptidæ 181
Diplograptus 217
— aculeatus 223
— acuminatus 289; XXXII, 11
— antennarius 300
— appendiculatus 255
— arctus... ... 271; XXXI, 16
— bellulus 231; XXIX, 2
— bimucronatus 323
— calcaratus ... 239; XXX, 1
— cœlatus ... 270; XXXI, 17
— cometa 285

Diplograptus compactus 262
— confertus (Nicholson) *263*, 269; XXXI, 18
— confertus (Lapworth) ... 349
— cyperoides 238
— dentatus 207, *252*, 253, *350*; XXXI, 4
— Etheridgii 296
— euglyphus 252
— fimbriatus 312
— foliaceus, *239*, *241*, *244*, 259; XXXI, 8
— — var. calcaratus ... 241
— — var. vulgatus ... 241
— folium 282
— Harknessi 325
— Hincksii 309
— Hopkinsoni 299
— Hughesi 208, 249
— insectiformis ... 228; XXVIII, 7
— inutilis 322
— longissimus 354
— magnus ... 266; XXXI, 14
— minimus 191
— modestus ... 263; XXXI, 11
— mucronatus 321
— multidens ... 261; XXXI, 9
— mutabilis ... 232; XXIX, 1
— ovato-elongatus 277
— ovatus 278
— Pageanus ... 225; XXVIII, 3
— palmeus ... 274, 277, 279
— penna 231
— perexcavatus ... 267; XXXI, 15
— persculptus ... 257; XXXI, 7
— physophora 353
— pristiniformis 253
— pristis 245
— quadrimucronatus 223; XXVIII, 1
— — var. spinigerus 225; XXVIII, 2
— ramosus 175
— rectangularis 187
— rugosus 245
— serratus ... 249; XXX, 10
— sextans 153
— sinuatus ... 255; XXXI, 6
— socialis 237
Diplograptus tamariscus ... 247; XXX, 8
— teretiusculus, *206*, *208*, 250; XXXI, 1
— tricornis 296
— truncatus ... 233; XXIX, 3
— tubulariformis ... 285, 287
— vesiculosus ... 229; XXVIII, 8
— Whitfieldi ... 227; XXVIII, 6

Fucoides dentatus 253
— serra 65

Gladiograptus 336, 346
— Geinitzianus ... 336; XXXIV, 8
— — var. angustidens 338; XXXIV, 9
— perlatus ... 338; XXXIV, 10
— — var. Daironi 340; XXXIV, 11
Gladiolites 336
— Geinitzianus 336
Glossograptidæ 304
Glossograptus 307, 315
— acanthus ... 314; XXXIII, 4
— armatus ... 312; XXXIII, 5
— ciliatus ... 309; XXXIII, 1
— echinatus 314
— fimbriatus 312
— Hincksii ... 309; XXXIII, 2
— — var. fimbriatus, 312; XXXIII, 3
Glyptograptus *221*, 247, 292
— dentatus ... *221*, 253; XXXI, 4
— — var. appendiculatus *221*, 255; XXXI, 5
— euglyphus 252
— persculptus ... *221*, 257 XXXI, 7
— serratus ... *221*, 249; XXX, 10
— — var. barbatus *221*, 250; XXX, 11
— sinuatus ... *221*, 255; XXXI, 6
— tamariscus ... *221*, 247; XXX, 8
— — var. incertus *221*, 249; XXX, 9
— teretiusculus, *221*, 250; XXXI, 1
— — var. euglyphus *221*, 252; XXXI, 2

Glyptograptus teretiusculus var. siccatus *221*, 253; XXXI, 3
Gothograptus 343, 346
— nassa ... ... 343; XXXIV, 15
spinosus ... 345; XXXIV, 16
"Graptolites" argenteus 388
— bryonoides 60
— colonus 379
— discretus 407
— fimbriatus 482
— griestoniensis 413
— lobiferus 448
— — var. exiguus 453
— ludensis var. minor 381
— millepeda 465
— Nicoli 448
— Nilssoni 365
— priodon *409*, 418
— tenuis 407
— vomerinus 409
"Graptolithus" acutus 485
— attenuatus 436
— Barrandei 367, 462
— Becki *432*, *448*, 452
— bicornis 193
— bifidus 42
— Bigsbyi 68
— bohemicus 367
— bryonoides 65
— chimæra 398
— Clingani 463
— colonus ... *376*, 391, *397*, *409*
— convolutus 467
— crucifer 58
— divaricatus 143
— divergens 122
— dubius 376
— ensiformis 301
— extensus 8
— flaccidus 106
— Flemingii 425
— foliaceus 259
— fruticosus 61
— geminus 40
— gracilis 126, 127
— Halli 443
— hamatus 510
— Headi 59
— indentus 45
"Graptolithus" intermedius 485
— Logani 81
— ludensis 394
— marcidus 296
— mucronatus 321
— Murchisoni 37
— Nilssoni 369
— nitidus 10
— octobrachiatus 77
— ovatus 278
— palmeus 274, 277
— — var. lata 275; XXXII, 2
— — var. tenuis 276
— patulus 13
— pennatulus 18
— plumosus 453
— proteus 477
— — var. plana 484
— quadribrachiatus 57
— quadrimucronatus 223
— ramosus 169, 175
— Richardsoni 76
— Roemeri 397
— scalaris 367
— Sedgwickii 441
— — var. spinigerus 441
— serratulus 29
— sextans 153
— spiralis 475
— teretiusculus 206
— turriculatus 438
— Whitfieldi 227

Hallograptus 320
— mucronatus .. 321; XXXIII, 6
— bimucronatus 323
— — var. nobilis 323; XXXIII, 9
Helicograpsus 125
— gracilis 127
Heteroprionidæ 347
Holograptus 74
— Deani ... ... 75; VIII, 2
— expansus 76
— Richardsoni 76

Idiograptus 317
— aculeatus 317
Isograptus 52

Isograptus gibberulus 52
Lasiograptidæ 304
Lasiograptus 318
— costatus 327
— fibratus ... 331; XXXIV, 5
— Harknessi ... 325; XXXIV, 1
— — var. costatus 327; XXXIV, 2
— margaritatus ... 332; XXXIV, 6
— mucronatus ... 321; XXXIII, 6
— — var. bimucronatus 323; XXXIII, 8
— — var. inutilis 322; XXXIII, 7
— — var. nobilis 324; XXXIII, 9
— retusus ... 328; XXXIV, 3
— velatus ... 329; XXXIV, 4
Lateral branching 70
Leptograptidæ 103
Leptograptus 104
— antiquus 134
— capillaris ... ... 112: XV, 4
— ascendens ... ...117; XVI, 6
— flaccidus ... ...106; XIV, 1
— — var. arcuatus 111; XV, 3
— — var. macer ... 110; XV, 2
— — var. macilentus 109; XIV, 3, XV, 1
— — var. spinifer, 108; XIV, 2
— grandis ... 115; XVI, 4
— latus ... ... 116; XVI, 5
— validus . 113; XVI, 1
— — var. incisus, 114; XVI, 2
Linograptus Nilssoni 370
Loganograptus 80
— Logani ... ... 81; XI, 1
Lomatoceras priodon 418
Mesograptus *221*, 258, 293
— foliaceus ...*221*, 259; XXXI, 8
— magnus *221*, 266; XXXI, 14
— modestus *221*, 263; XXXI, 11
— — var. diminutus *221*, 265; XXXI, 13
— — var. parvulus *221*, 264; XXXI, 12
— multidens *221*, 261; XXXI, 9
— — var. compactus *221*, 262; XXXI, 10
Microscope, Parkes-Lapworth 3
Monograptidæ 359
Monograptus 359, 496, 502
— acinaces ... 364; XXXVI, 2
— acus ... ... 431; XLIII, 7
— approximatus var. Geinitzi 492; L, 5
— argenteus ... 388; XXXVIII, 5
— — var. cygneus 389; XXXVIII, 6
— argutus ... ... 408; XL, 3
— atavus ... 403; XXXIX, 1
— attenuatus 436
— Barrandei ... 462; XLVI, 6
— Becki ... ... 452; XLV, 4
— bohemicus ... 367; XXXVI, 4
— broughtonensis 431
— capillaceus ... 458; XLVI, 4
— chimæra ... 398; XXXIX, 3
— — var. Salweyi 400; XXXIX, 5
— — var. semispinosus 401; XXXIX, 4
— circularis ... 479; XLVIII, 9
— Clingani ... 463; XLVI, 11
— colonus 391, *395*, 397; XXXVIII, 8
— — var. compactus 393; XXXVIII, 10
— — var. ludensis 394; XXXVIII, 9
— comis ... ... 381; XXXVII, 9
— communis ... 480; XLIX, 1
— — var. rostratus 481; XLIX, 2
— concinnus ... 368; XXXVI, 5
— convolutus ... 467; XLVII, 1
— — var. communis ... 480
— — var. fimbriatus ... 483
— crassus 443
— crenularis ... ...414; XLI, 7
— crenulatus 412
— crinitus ... 435; XLIV, 3
— crispus ... 456; XLV, 6
— cultellus ... 423; XLII, 9
— cygneus 389
— cyphus ... 362; XXXVI, 1
— fimbriatus ... 482; XLVIII, 4
— — var. similis 483 XLVIII, 5

Monograptus flagellaris ... 457; XLVI, 3
— Flemingii ... 425; XLII, 5
— — var. compactus 427; XLII, 7
— var. primus 426; XLII, 6
— flexilis ... ... 430; XLIII, 4
— fugax ... ... 493; L, 7
— galaensis ... 415; XLII, 1
— var. basilicus ... 411
— gemmatus 436, 456; XLIII, 5
— gotlandicus ... 382; XXXVII, 8
— gregarius ... 365; XXXVI, 3
— griestoniensis ... 413; XLI, 5
— decipiens ... 469; XLVII, 3
— delicatulus ... 478; XLVII, 2
— densus 421
— denticulatus ... 474; XLVIII, 2
— dextrorsus ... 460; XLVI, 7
— difformis ... 386; XXXVIII, 4
— discus ... ... 439; XLIV, 5
— distans ... 433; XLIII, 6
— dubius ... ... 376; XXXVII, 7
— elongatus ... 486; XLIX, 5
— equidistans ... ... 500; LI, 2
— exiguus ... 453; XLVI, 1
— Halli ... ... 443; XLIV, 8
— harpago 448
— Hisingeri 375
— — var. jaculum ... 373
— — var. nudus 375
— — var. variabilis ... 374
— hybridus ... ... 491; L, 4
— incommodus ... ... 406; XL, 1
— intermedius ... 485; XLIX, 3
— — var. involutus ... 478
— involutus ... 478; XLIX, 4
— irfonensis ... 429; XLIII, 3
— jaculum ... 373; XXXVII, 4
— Jaekeli ... 435; XLIV, 1
— knockensis ... 462; XLVI, 8
— leintwardinensis 401; XXXIX, 8
— — var. incipiens 402; XXXIX, 9
— leptotheca ... 371; XXXVII, 2
— limatulus ... 390; XXXVIII, 7
— Linnæi ... ... 493; LI, 1
— lobiferus ... 448, *465*; XLV, 1
— var. pandus ... 421
— longispinus ... ... 489; L, 2
Monograptus M'Coyi ... 446; XLIV, 9
— Marri ... ... 422; XLII, 4
— maximus ... ... 494; L, 6
— millepeda ... 465; XLVI, 10
— Nilssoni ... 369; XXXVII, 1
— nodifer ... 454; XLVI, 2
— nudus ... ... 375; XXXVII, 6
— pandus ... 421; XLII, 3
— peregrinus ... ... 488; L, 1
— planus ... ... 484; XLVIII, 6
— priodon ... 418; XLII, 2
— proteus ... 477; XLVIII, 8
— raitzhainiensis 473; XLVIII, 3
— regularis ... 372; XXXVII, 3
— remotus ... 461; XLVI, 9
— resurgens 484
— retroflexus ... 459; XLVI, 5
— revolutus 384; XXXVIII, 1
— — var. austerus 385; XXXVIII, 2
— — var. præcursor 386; XXXVIII, 3
— rheidolensis 364
— riccartonensis ... 424; XLII, 8
— Roemeri *391*, 397; XXXIX, 2
— runcinatus ... 450; XLV, 2
— — var. pertinax 451; XLV, 3
— Salweyi 400
— Sandersoni ... 404; XXXIX, 10
— scanicus ... 433; XLIV, 2
— Sedgwickii ... 441; XLIV, 10
— serra 376
— setiger ... ... 490; L, 3
— spiralis ... 475; XLVIII, 7
— — β. subconicus 475
— tenuis ... ... 407; XL, 2
— testis var. inornatus, 446; XLIV, 7
— tortilis ... ... 440; XLIV, 6
— triangulatus ... 471; XLVII, 4
— — var. major 472; XLVII, 5
— — var. Raitzhainiensis, 473
— tumescens ... 379; XXXVII, 12
— — var. minor 381; XXXVII, 13
— turriculatus ... 438; XLIV, 4
— ultimus ... 383; XXXVII, 14

Monograptus uncinatus var. micropoma 428; XLIII, 2
— — var. orbatus 427; XLIII, 1
— undulatus ... 432; XLV, 5
— urceolus ... 470; XLVIII, 1
— variabilis ... 374; XXXVII, 5
— varians ... 395; XXXIX, 6
— — var. pumilus 396; XXXIX, 7
— vomerinus ... ...409; XLI, 1
— — var. basilicus 411; XLI, 2
— — var. crenulatus 412; XLI, 4
— — var. gracilis, 411; XLI, 3
— vulgaris ... 378; XXXVII, 10
— — var. curtus 379; XXXVII, 11

Nema 6
Nemagraptidæ 103
Nemagraptus 125
— capillaris 112
— descendens 132
— elegans 126, 127
— explanatus ... 133; XIX, 6
— — var. pertenuis 134; XIX, 7
— gracilis ... 127; XIX, 1
— — var. nitidulus 131; XIX, 4
— — var. remotus 130; XIX, 3
— — var. surcularis 129; XIX, 2
Neurograptus 331
— fibratus ... 331; XXXIV, 5
— margaritatus ... 332; XXXIV, 6
Nymphograptus 329
— velatus ... 329; XXXIV, 4

Obverse 6
"Orthoceratites" tenuis 184
Orthograptus *220*, 222, 290
— basilicus 243
— bellulus ...*220*, 231; XXIX, 2
— calcaratus ... *220*, 239; XXX, 1
— — var. acutus *220*, 242; XXX, 3
— — var. basilicus *220*, 243; XXX, 2
Orthograptus calcaratus var. priscus *220*, 244; XXX, 6
— — var. tenuicornis 243; XXX, 4
— — var. vulgatus *220*, 241; XXX, 5
— cyperoides *220*, 238
— insectiformis, *220*, 228; XXVIII, 7
— mutabilis ...*220*, 232; XXIX, 1
— Pageanus *220*, 225; XXVIII, 3
— — var. abnormispinosus *220*, 226; XXVIII, 5
— — var. micracanthus *220*, 226; XXVIII, 4
— quadrimucronatus *220*, 223; XXVIII, 1
— — var. spinigerus *220*, 225; XXVIII, 2
— rugosus ... *220*, 245; XXX, 7
— — var. apiculatus *220*, 245; XXX, 7
— truncatus ...*220*, 233; XXIX, 3
— — var. abbreviatus *220*, 235; XXIX, 6
— — var. intermedius *220*, 236; XXIX, 4
— — var. pauperatus *220*, 237; XXIX, 5
— — var. socialis *220*, 237; XXIX, 7
— vesiculosus *220*, 229; XXVIII, 8
— — var. penna *220*, 231; XXVIII, 9
— Whitfieldi *220*, 227; XXVIII, 6

Parkes-Lapworth Microscope 3
Petalograptus *221*, 273, 294
— altissimus *222*, 281; XXXII, 7
— folium... *221*, 282; XXXII, 8
— minor ... *222*, 279; XXXII, 5
— ovatus ... ... 278; XXXII, 6
— palmeus *222*, 274; XXXII, 1
— — var. lata *222*, 275; XXXII, 2
— — var. ovato-elongatus *222*, 277; XXXII, 4
— — var. tenuis *222*, 276; XXXII, 3
— (?) phylloides *222*, 284; XXXII, 16

Petalolithus 273
— ovatus... 278
— palmeus 274, 277
— parallelo-costatus 274
Phyllograptus 98
— angustifolius... 100; XIII, 7
— anna ... ... 101; XIII, 6
— ilicifolius, var. grandis 102; XIII, 8
— similis 68
— stella... 52
— typus... ... ... 99; XIII, 5
Plegmatograptus 340, 346
— nebula ... 340; XXXIV, 14
— obesus ... 342, XXXIV, 12
— — var. macilentus 343; XXXIV, 13
Pleurograptus 119
— linearis 119; XVI, 7; XVII, 1
— - var. simplex 121; XVII, 2
— vagans ... ... 72; VI, 9
Pomatograptus micropoma 428
Prionotus 206
— convolutus 467
— folium 282
— geminus 40
— scalaris 184
— Sedgwickii 441
— teretiusculus 250
Pristiograptus bohemicus 367
— colonus 391, *398*
— frequens 379
— gregarius 365
— Nilssoni 369
— Roemeri 397
— uncinatus 401

Rastrites 504
— approximatus var. Geinitzi 492; L, 5
— Barrandi 127
— capillaris 436
— distans 500
— — var. abbreviatus 500
— equidistans ... ... 500; LI, 2
— fugax ... ... 493; L, 7
— gemmatus 436
— hybridus ... ... 491; L, 4
— Linnæi ... ... 493; LI, 1
— longispinus ... ... 489; L, 2
Rastrites maximus ... ... 494; L, 6
— peregrinus ... ... 488; L, 1
— — var. hybridus 491
— — var. longispinus 489; L, 2
— setiger ... ... 490; L, 3
— triangulatus 471
— urceolus 470
Retiograptus 315
— aculeatus 317
— Barrandi 316
— eucharis 318
— Geinitzianus ... 316; XXXIV, 7
Retiolitidæ 333
Retiolites 335, 346
— ensiformis 302
— fibratus 331
— Geinitzianus ... 336; XXXIV, 8
— — var. angustidens 338; XXXIV, 9
— macilentus... 343
— nassa ... ... 343; XXXIV, 15
— nebula ... ... 340; XXXIV, 14
— obesus ... ... 342; XXXIV, 12
— — var. macilentus 343; XXXIV, 13
— perlatus ... 338; *342*; XXXIV, 10
— — var. Daironi 340; XXXIV, 11
— — var. obesus 342
— spinosus ... ... 345; XXXIV, 16
Reverse 6
Rouvilligraptus 74
— Richardsoni 76

Schizograptus 70
— reticulatus ... ... 71; VI, 7
— tardifurcatus... ... 72; VI, 8
Sicula 6
Stephanograptus 125
— gracilis 127
Stipe 6

Temnograptus 85
— multiplex ... ... 86; XII, 1
Tetragraptus 55
— Amii ... ... 60; V, 4
— Bigsbyi ... ... 68; VI, 6
— bryonoides 65
— crucialis 57
— crucifer ... ... 58; V, 2

Tetragraptus fruticosus ... ... 61; VI, 2
— Halli 65
— Headi ... ... 59; V, 3
— Hicksii 94
— pendens ... ... 63; VI, 3
— Postlethwaitii ... ... 64; VI, 1
— quadribrachiatus ... 57; V, 1
— reclinatus ... ... 67; VI, 5
— serra ... ... 52, 65; VI, 4
Theca 6
Thysanograptus 325
— Harknessi ... 325; XXXIV, 1
— — var. costatus 327; XXXIV, 2
Thysanograptus retusus ... 328; XXXIV, 3
Trichograptus 90
— fragilis ... ... 91; XII, 5
— tenellus 83
Trigonograptus 301
— ensiformis ... 302; XXXV, 1
— — var. lanceolatus 303; XXXV, 2
— lanceolatus 303
Trochograptus 73
— diffusus ... 73; VII, VIII, 1

Zonal Range of British Graptoloidea ... 514

ALPHABETICAL INDEX

OF AUTHORITIES REFERRED TO IN THE HISTORY OF RESEARCH,

WITH THE DATES OF THE PUBLICATIONS CITED.

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Ami, H. M., 1904.

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Törnquist, S. L., 1864–65, 1867, 1876, 1879, 1880, 1881, 1883, 1887, 1890, 1892 (two), 1893, 1894 (two), 1897, 1899, 1901, 1904, 1905, 1906, 1907, 1910, 1911, 1912, 1913.
Touche, T. H. D. La, 1913.
Tullberg, 1880, 1882 (two), 1883.

Ulrich, E. O., 1913.

Vanuxem, L., 1842.
Verneuil, E. de, 1850.

Wade, A., 1911.
Wahlenberg, G., 1821.
Walch, 1771.
Walther (and Lapworth), 1897.
Watney, G. R. (and Welch, E. G.), 1911.
Welch, E. G. (and Watney, G. R.), 1911.
Westergård, A. H., 1909.
White, C. A., 1875.
Wiman, C., 1893 (two), 1895, 1896, 1897.
Wood, E. M. R. (Mrs. Shakespear), 1900, 1906 (two), 1908, 1910. (See also Elles and Wood.)

Zittel, K. A. von, 1879.

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